

Prayoga worksheets: Physics

29 experiments · Predict, Measure, Observe, Explain · draft 16 October 2026

Prayoga in Physics at a glance

Class	Chapters	Board practicals	Prayoga experiments	What's new with Prayoga
Class 10	5	5	13 across 5 chapters	Live V-I graph from the phone; magnetic field and solar power measured, not just read about
Class 9	5	4	8 across 5 chapters	Phone's own motion, sound and magnetic sensors measure g, speed and frequency; no kit needed
Classes 6–8	Textbook topics	No board list	8	Hot, cold, light, circuits, magnets and sound become real numbers on a screen
Total			29 experiments	One kit + phone, by cable or Bluetooth, no battery inside; live graphs in Kannada; a worksheet for every experiment

Chapters: science chapters in that class's textbook. Board practicals: practicals the board prescribes. Prayoga experiments: every worksheet in this file for that class.

Prayoga experiments chapter by chapter

Class	Chapter or topic	Prayoga experiments (worksheet number)
10	Electricity	1 Ohm's law; 2 Resistance and length of a wire; 3 Resistors in series and parallel; 4 Heating effect of current
10	Magnetic Effects of Electric Current	5 Magnetic field around a wire; 6 Field of a solenoid; 7 Magnet through a coil (induction)
10	Light: Reflection and Refraction	8 Light and distance; 9 Light through glass and water
10	Human Eye and the Colourful World	10 Spectrum of different lamps; 11 Why the sky is blue
10	Sources of Energy	12 Solar cell output; 13 Inside a solar cooker
9	Motion	14 Trolley on a ramp: speed and acceleration
9	Force and Laws of Motion	15 Force, mass and acceleration
9	Gravitation	16 Measuring g with a pendulum
9	Work and Energy	17 Energy in a swinging pendulum
9	Sound	18 Frequency and pitch; 19 Speed of sound from an echo; 20 Reflection of sound; 21 Speed of a pulse along a slinky
6–8	Heat	22 Hot and cold; 23 Which cup keeps tea warm?
6–8	Light, Shadows and Reflections	24 Transparent, translucent, opaque
6–8	Electricity and Circuits	25 Does the bulb glow?; 26 Conductors and insulators
6–8	Fun with Magnets	27 Magnet strength and distance
6–8	Sound	28 Loud and soft, high and low
6–8	Sources of Energy	29 Solar cell: sun, cloud and shade

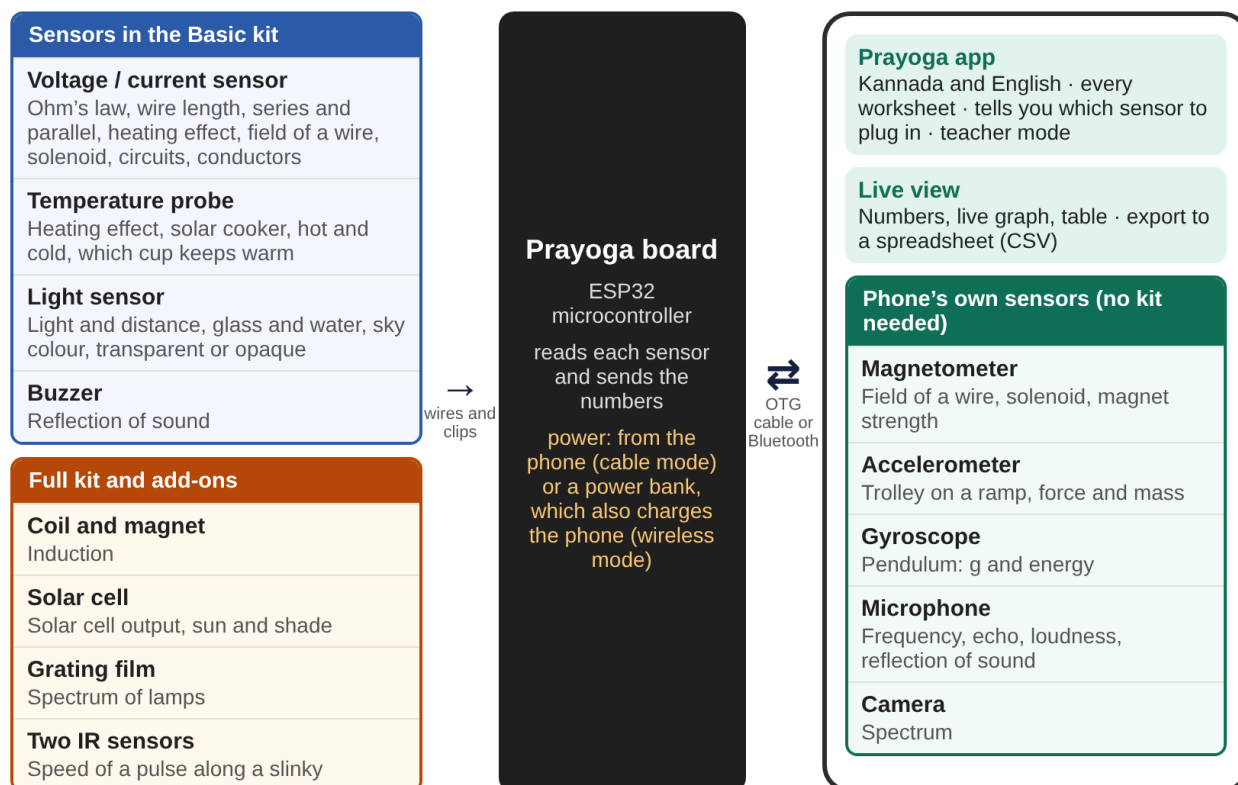
How to use these worksheets

1. **Print** each worksheet on both sides of one sheet. Front: a picture of the setup and every instrument, then predict, measure, set up and record. Back: the graph to plot and the questions.
2. **Before class**, the teacher tries the experiment once, charges the phones, and checks the label under the title. It says what the worksheet needs: the Basic kit, the Full kit, only the phone, by hand, or the shared USB microscope.
3. **In class**, groups of 5–6 work through the four steps in order: Predict, Measure by hand, Set up Prayoga and observe, Explain. Nobody opens the app until predictions are written.
4. **Students plot by hand first**, then compare with the app's live graph. The hand reading and hand graph keep the skills the exam tests.
5. **After class**, collect the sheets and mark them with the answer key at the end of this file.

Prayoga for Physics

Prayoga for Physics: how the parts work together

Sensors measure → the Prayoga board reads them five times a second → the phone shows live numbers and graphs. Cable mode: the phone powers the kit. Wireless mode: a power bank powers the kit and charges the phone, with data over Bluetooth.



By hand, alongside Prayoga: Multimeter, lab thermometer, metre scale, stopwatch, protractor, galvanometer. Students take these readings first, then check them against the sensor.

Setting up Prayoga (every experiment that uses the kit)

1. Plug the sensor or probe named on the worksheet into the kit (the "Set up Prayoga" box says which).
2. Connect the kit in one of two ways. **Cable mode:** plug the kit into the phone with the USB OTG cable; the phone powers the kit and the readings travel through the cable, so no other power is needed. **Wireless mode:** plug a power bank or 5 V charger into the kit's POWER IN port and connect by Bluetooth in the app; the phone can charge from the kit's CHARGE OUT port at the same time. Each kit has its own name (for example Prayoga-07), so groups connect to the right one.
3. Open the **Prayoga app** and choose the subject, class and experiment. The app shows which sensor to plug in and opens the right view.
4. Tap **Start** to record and **Stop** to finish, then **Save**. Saved readings can be shared as a spreadsheet. Experiments that use only the phone's own sensors (motion, sound, magnetism, camera) need no kit.

The four steps on every worksheet

Step	What students do
1 Predict	Write what they expect and why, and sketch the graph, before touching the kit.
2 Measure by hand	Use a thermometer, multimeter, scale, stopwatch or pH paper, and work out its least count. This keeps the instrument skills the exam tests.
3 Set up Prayoga and observe	Follow the “Set up Prayoga” box, run the experiment, fill the table, plot by hand, then compare with the app.
4 Explain	Compare with the prediction, explain differences, answer exam-style questions.

In class

- One kit per group of 5–6 students. Roles, rotated each time: **Builder**, **Reader** (plain instrument), **App operator**, **Recorder**, **Explainer**.
- A 40-minute period: predict 5 min · hand reading 5 min · observe and plot 15 min · explain 10 min · report back 5 min. Long experiments (over hours or days) are started in one period and finished later.
- The label under each title says what is needed. **Basic kit**: board, voltage/current sensor, temperature probe, light sensor, pressure sensor, buzzer and circuit parts. **Full kit**: adds pH and conductivity probes, clip-on microscope lens, coil and magnet, solar cell, grating film, IR sensors and the LED test-tube holder. **Lab add-on**: one USB microscope shared by the school.
- Teacher answers are at the end of this file.

Worksheets (29; 24 need only the Basic kit, the phone or hand methods)

No.	Worksheet	Class	Chapter	Status
1	Ohm's law	Class 10	Electricity	Basic kit
2	Resistance and length of a wire	Class 10	Electricity	Basic kit
3	Resistors in series and parallel	Class 10	Electricity	Basic kit
4	Heating effect of current	Class 10	Electricity	Basic kit
5	Magnetic field around a wire	Class 10	Magnetic Effects of Electric Current	Basic kit + phone sensor
6	Field of a solenoid	Class 10	Magnetic Effects of Electric Current	Basic kit + phone sensor
7	Magnet through a coil (induction)	Class 10	Magnetic Effects of Electric Current	Full kit
8	Light and distance	Class 10 (graph skills)	Light	Basic kit
9	Light through glass and water	Class 10	Light: Reflection and Refraction	Basic kit
10	Spectrum of different lamps	Class 10	Human Eye and the Colourful World	Full kit
11	Why the sky is blue	Class 10	Human Eye and the Colourful World	Basic kit
12	Solar cell output	Class 10	Sources of Energy	Full kit
13	Inside a solar cooker	Class 10	Sources of Energy	Basic kit
14	Trolley on a ramp: speed and acceleration	Class 9	Motion	Phone only (Prayoga app)
15	Force, mass and acceleration	Class 9	Force and Laws of Motion	Phone only (Prayoga app)
16	Measuring g with a pendulum	Class 9	Gravitation	Phone only (Prayoga app)
17	Energy in a swinging pendulum	Class 9	Work and Energy	Phone only (Prayoga app)
18	Frequency and pitch	Class 9	Sound	Phone only (Prayoga app)
19	Speed of sound from an echo	Class 9	Sound	Phone only (Prayoga app)
20	Reflection of sound	Class 9	Sound	Basic kit + phone sensor
21	Speed of a pulse along a slinky	Class 9	Sound (waves)	Full kit
22	Hot and cold	Class 7	Heat	Basic kit

No.	Worksheet	Class	Chapter	Status
23	Which cup keeps tea warm?	Class 7	Heat	Basic kit
24	Transparent, translucent, opaque	Class 6	Light, Shadows and Reflections	Basic kit
25	Does the bulb glow?	Class 6	Electricity and Circuits	Basic kit
26	Conductors and insulators	Class 6	Electricity and Circuits	Basic kit
27	Magnet strength and distance	Class 6	Fun with Magnets	Phone only (Prayoga app)
28	Loud and soft, high and low	Class 8	Sound	Phone only (Prayoga app)
29	Solar cell: sun, cloud and shade	Class 8	Sources of Energy	Full kit

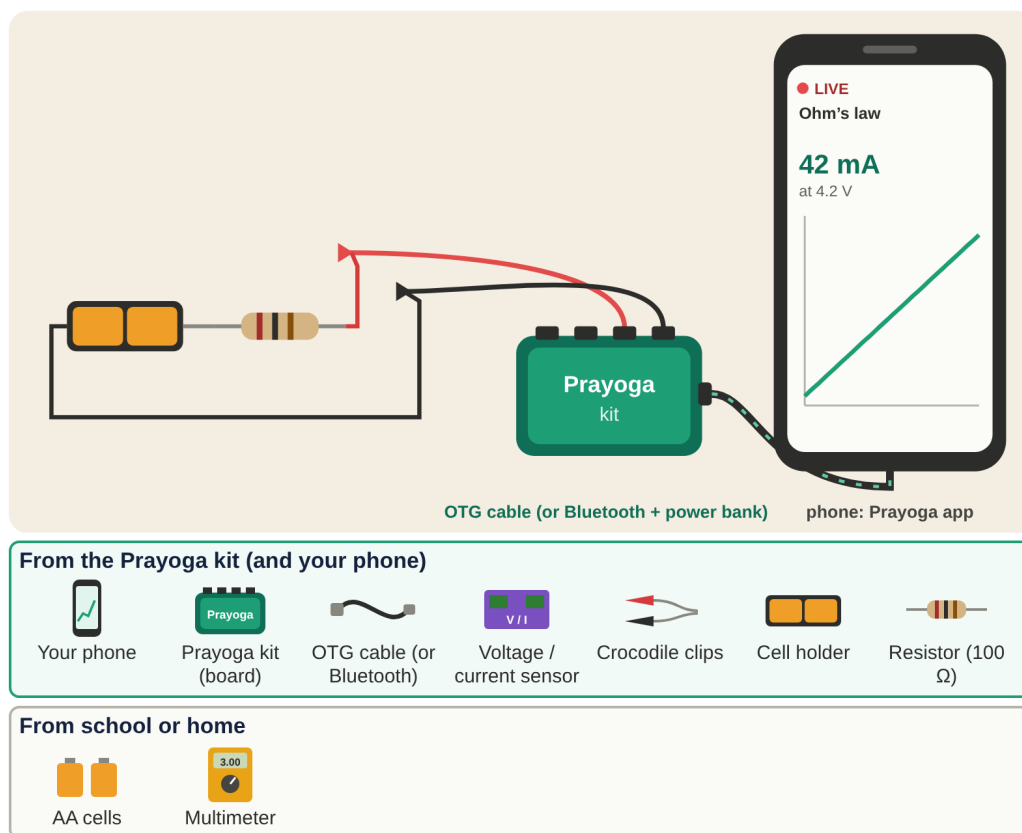
1. Ohm's law

Class 10 • Electricity **Basic kit**

Name _____ Class _____ Group _____ Date _____

You need: Prayoga kit (voltage/current sensor), holder for 4 AA cells, one 100 Ω resistor, crocodile clips, digital multimeter.

Safety: Cells only. Never connect the battery's + and - directly together.



Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

If the voltage across the resistor is doubled, the current will: ☐ double ☐ halve ☐ stay the same

Why do you think so?



Sketch the graph you expect

2 Measure by hand

- Set the multimeter to DC volts (20 V range) and measure the voltage of 2 cells: _____ V. What is the smallest change the display shows on this range? _____ V

3 Set up Prayoga, then observe

Set up Prayoga

- Clip the circuit to the voltage/current sensor as in the steps below.
- Connect the kit: OTG cable to the phone (cable mode), or power bank in and Bluetooth on (wireless mode). Open the Prayoga app and choose this experiment. It opens the **Voltage and current** view and draws the live graph.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

- Connect battery + to VIN+, VIN- to the resistor, and the resistor's other end to battery - (and kit GND).
- Start recording in the app. Record readings with 1, 2, 3 and 4 cells.

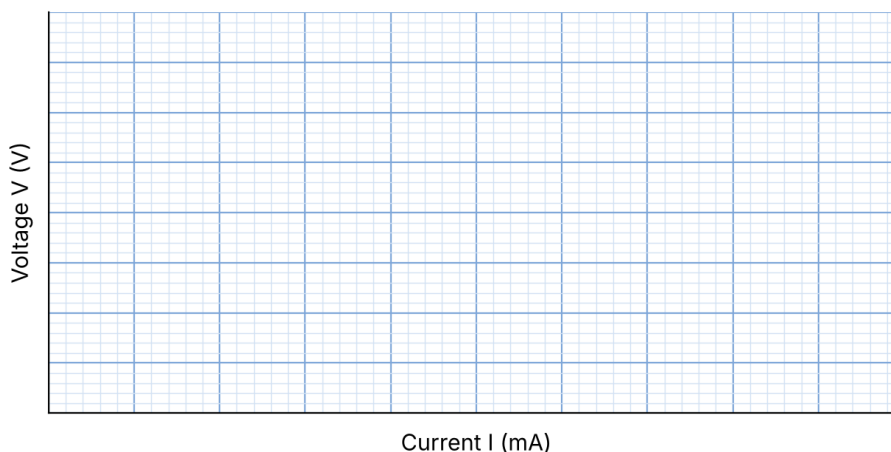
Write your readings in the table on the back.

3 Record your readings • Ohm's law

Cells	V (V)	I (mA)	I (A)	$R = V \div I$ (Ω)
1				
2				
3				
4				

3 Plot your results • Ohm's law

Plot your points by hand and draw the best line or smooth curve. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) What does a straight line through zero tell you about V and I?

c) Find R from the slope of your graph. Is it close to 100 Ω ?

Exam-style questions

1. State Ohm's law. (1 mark)

2. Draw a circuit diagram to verify Ohm's law using a battery, plug key, resistor, rheostat, ammeter and voltmeter. (3 marks)

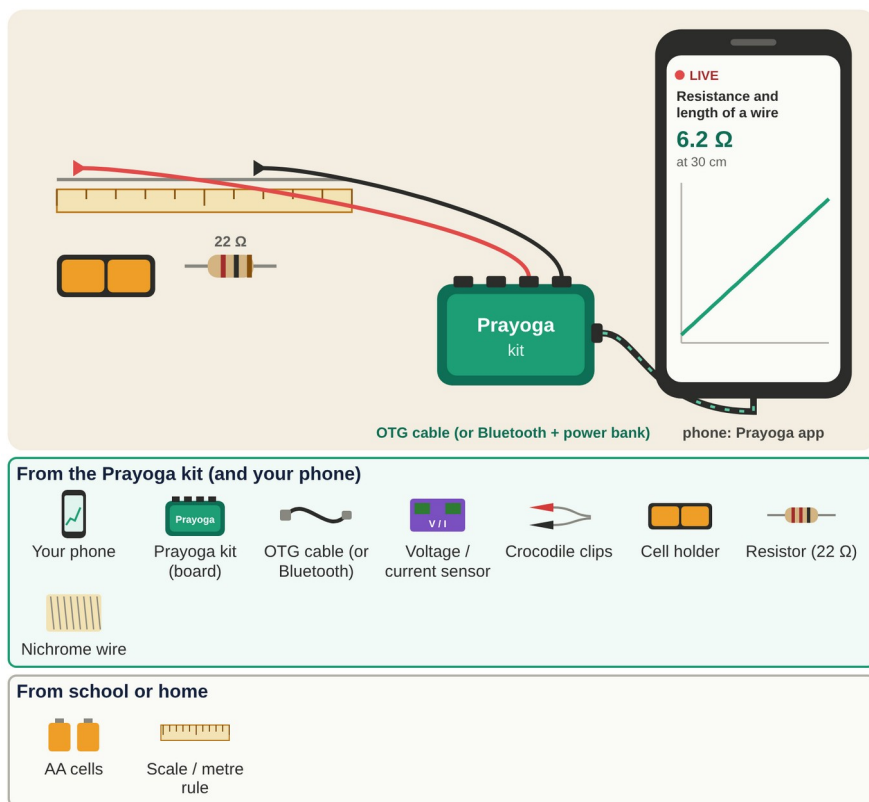
2. Resistance and length of a wire

Class 10 • Electricity **Basic kit**

Name _____ Class _____ Group _____ Date _____

You need: Prayoga kit, holder for 2 AA cells, 50 cm of thin nichrome wire taped along a metre scale, one $22\ \Omega$ resistor, crocodile clips.

Safety: Keep the $22\ \Omega$ resistor in the circuit: it limits the current. The wire may get warm.

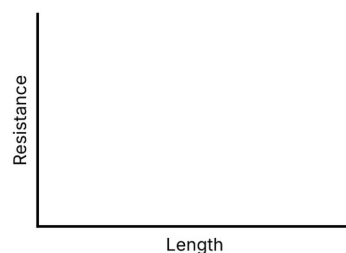


Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

If the length of the wire is doubled, its resistance will: ☐ double ☐ halve ☐ stay the same

Why do you think so?



Sketch the graph you expect

2 Measure by hand

1. Least count of the metre scale: _____ cm. Measure each length from the fixed clip to the moving clip.

3 Set up Prayoga, then observe

Set up Prayoga

- Clip the circuit to the voltage/current sensor as in the steps below.
- Connect the kit: OTG cable to the phone (cable mode), or power bank in and Bluetooth on (wireless mode). Open the Prayoga app and choose this experiment. It opens the **Voltage and current** view and draws the live graph.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Battery + → $22\ \Omega$ resistor → VIN+. VIN- → fixed clip at the 0 cm end of the wire. Moving clip → battery - and kit GND.
2. Move the clip to 10, 20, 30, 40 cm. Read V, I and R on the app screen (R is the wire alone).

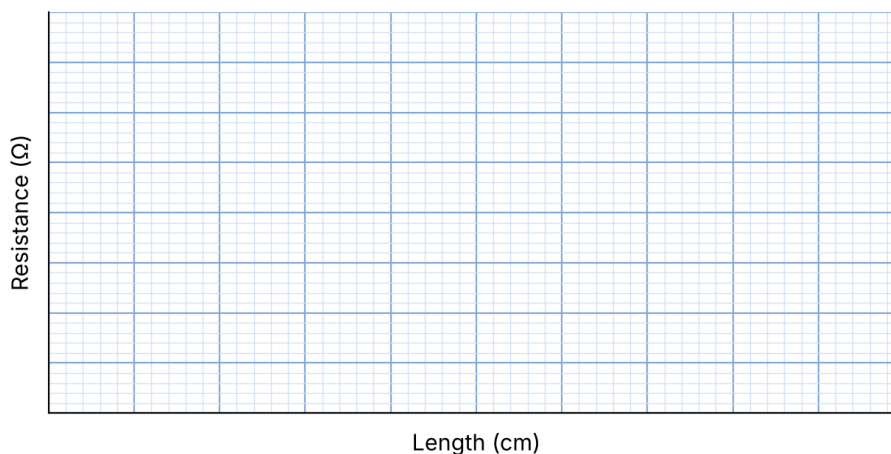
Write your readings in the table on the back.

3 Record your readings • Resistance and length of a wire

Length (cm)	V (V)	I (mA)	R (Ω)	R $\div$ length (Ω /cm)
10				
20				
30				
40				

3 Plot your results • Resistance and length of a wire

Plot your points by hand and draw the best line or smooth curve. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) Is $R \div \text{length}$ about the same in every row? What does that mean?

c) Use your graph to predict R at 50 cm, then measure it.

Exam-style questions

1. On what factors does the resistance of a conductor depend? (2 marks)

2. A wire of resistance $6\ \Omega$ is cut into two equal halves. What is the resistance of each half? (1 mark)

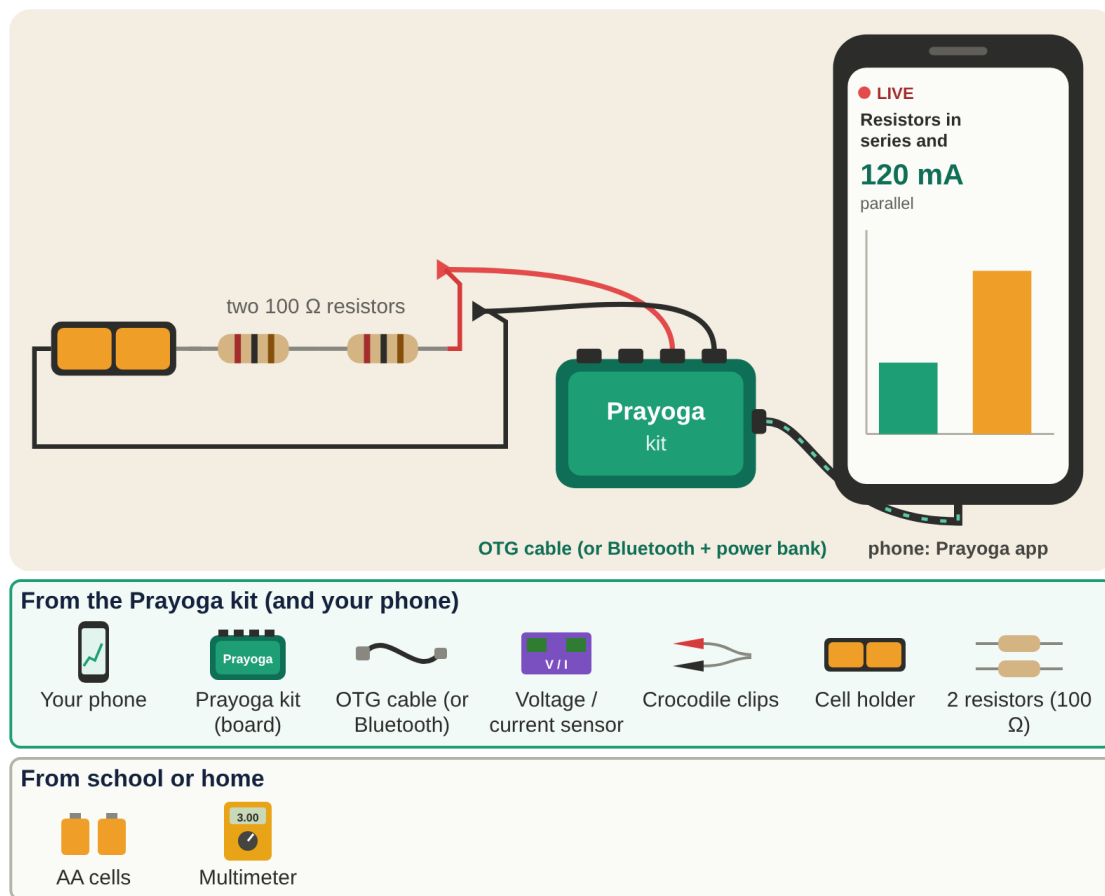
3. Resistors in series and parallel

Class 10 • Electricity **Basic kit**

Name _____ Class _____ Group _____ Date _____

You need: Prayoga kit, holder for 4 AA cells, two 100 Ω resistors, crocodile clips, digital multimeter.

Safety: The sensor reads up to 0.4 A. Do not use resistors smaller than 47 Ω in parallel.



Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

Compared with one resistor, two equal resistors in parallel will make the current: ☐ larger ☐ smaller ☐ the same
Why do you think so?

2 Measure by hand

1. Measure each resistor with the multimeter (Ω range): $R_1 = \text{_____} \Omega$, $R_2 = \text{_____} \Omega$.

3 Set up Prayoga, then observe

Set up Prayoga

- Clip the circuit to the voltage/current sensor as in the steps below.
- Connect the kit: OTG cable to the phone (cable mode), or power bank in and Bluetooth on (wireless mode). Open the Prayoga app and choose this experiment. It opens the **Voltage and current** view and draws the live graph.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Record V and I with one resistor.
2. Connect both resistors in series; record. Then connect them in parallel; record.
3. Work out $R = V \div I$, and R from the formula, for each.

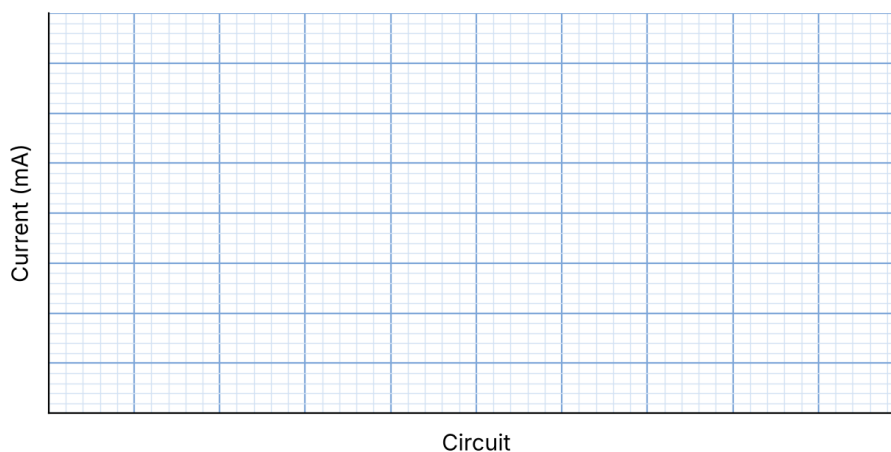
Write your readings in the table on the back.

3 Record your readings • Resistors in series and parallel

Circuit	V (V)	I (mA)	$R = V \div I$ (Ω)	R by formula (Ω)
One resistor				
Series				
Parallel				

3 Plot your results • Resistors in series and parallel

Draw a bar chart by hand. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) Does series $R = R_1 + R_2$? Does parallel $1/R = 1/R_1 + 1/R_2$?

c) Why are the lights and fans in a house connected in parallel?

Exam-style questions

1. Resistors of $4\ \Omega$ and $6\ \Omega$ are connected (a) in series and (b) in parallel. Find the equivalent resistance in each case. (3 marks)

2. Give two advantages of connecting appliances in parallel. (2 marks)

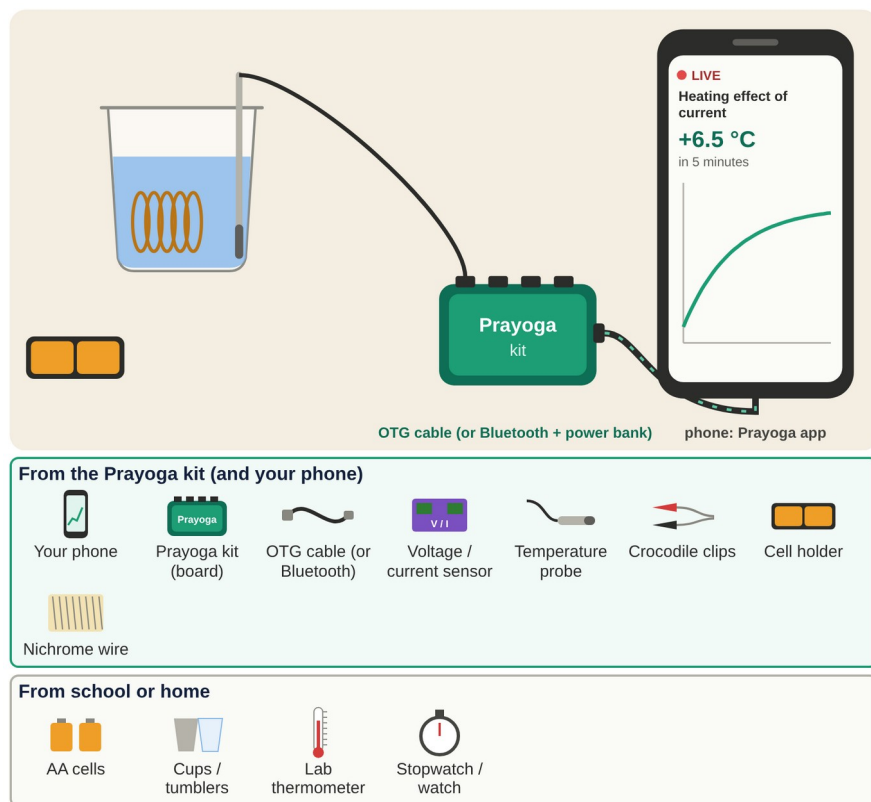
4. Heating effect of current

Class 10 • Electricity **Basic kit**

Name _____ Class _____ Group _____ Date _____

You need: Prayoga kit (current sensor and temperature probe), holder for 4 AA cells, about 1 m of thin nichrome wire (15–20 Ω) wound into a coil, small cup with 30 mL water, lab thermometer, watch.

Safety: The coil must be at least 15 Ω so the current stays below 0.4 A. Do not touch the coil while current flows.

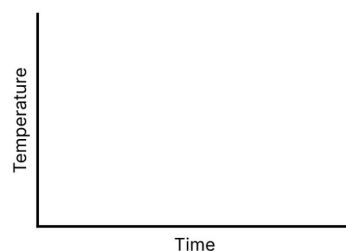


Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

If the current is doubled, the heat produced in the same time will be about: ☐ double ☐ four times ☐ the same

Why do you think so?



Sketch the graph you expect

2 Measure by hand

1. Read the starting water temperature on the lab thermometer: _____ $^{\circ}\text{C}$ (least count _____ $^{\circ}\text{C}$).

3 Set up Prayoga, then observe

Set up Prayoga

- Plug in the temperature probe and clip the coil circuit to the voltage/current sensor.
- Connect the kit: OTG cable to the phone (cable mode), or power bank in and Bluetooth on (wireless mode). Open the Prayoga app and choose this experiment. It opens the **Current and temperature** view and draws the live graph. Both are recorded together.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Put the coil and probe in the water. Pass current from 2 cells for 5 minutes; record temperature every minute. Current: _____ mA.
2. Use fresh water at the same starting temperature and repeat with 4 cells. Current: _____ mA.

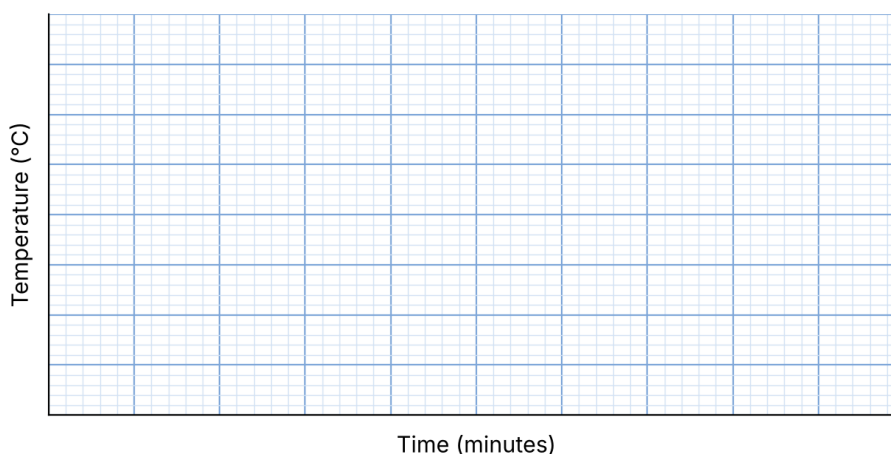
Write your readings in the table on the back.

3 Record your readings • Heating effect of current

Minute	Temperature, 2 cells (°C)	Temperature, 4 cells (°C)
0		
1		
2		
3		
4		
5		

3 Plot your results • Heating effect of current

Plot your points by hand and draw the best line or smooth curve. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) Rise with 4 cells ÷ rise with 2 cells = _____. Compare with (current with 4 cells ÷ current with 2 cells)².

c) Why is nichrome used in heaters and irons?

Exam-style questions

1. State Joule's law of heating. (2 marks)

2. Calculate the heat produced in 5 minutes when 0.3 A flows through a 20 Ω wire. (2 marks)

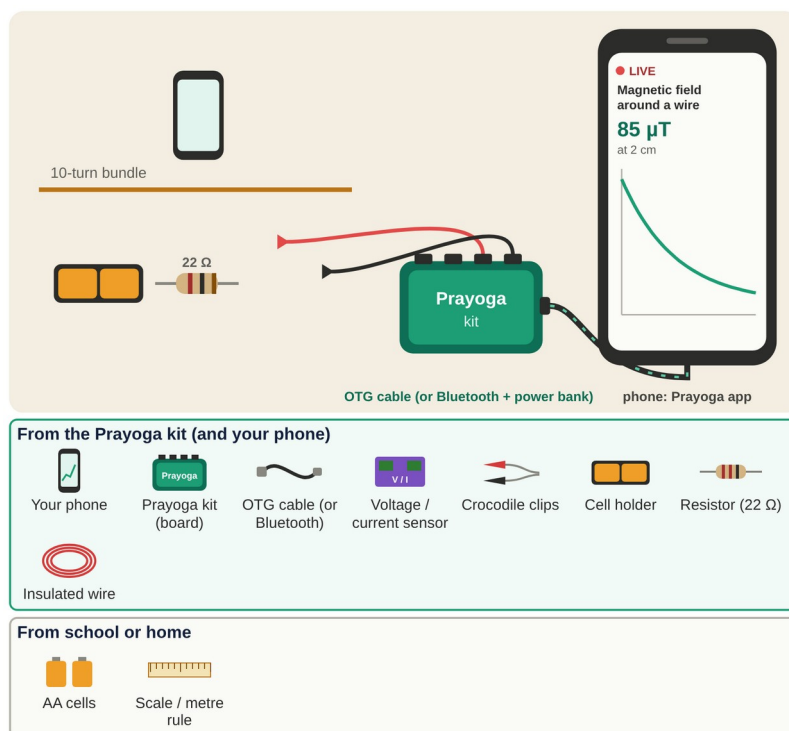
5. Magnetic field around a wire

Class 10 • Magnetic Effects of Electric Current **Basic kit + phone sensor**

Name _____ Class _____ Group _____ Date _____

You need: Prayoga kit, holder for 4 AA cells, 22 Ω resistor, 2 m of insulated wire, phone with the Prayoga app, scale, tape.

Safety: Keep the 22 Ω resistor in the circuit. Switch off between readings so the cells do not run down.

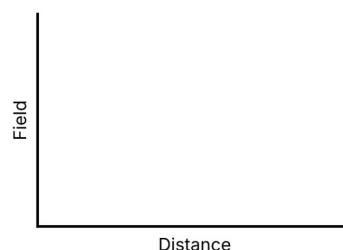


Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

Moving the phone twice as far from the wire, the field from the current will: ☐ double ☐ about half ☐ stay the same

Why do you think so?



Sketch the graph you expect

2 Measure by hand

1. Measure each distance from the wire to the phone's magnetometer (usually near the top edge) with the scale.

3 Set up Prayoga, then observe

Set up Prayoga

- Clip the circuit to the voltage/current sensor.
- Connect the kit: OTG cable to the phone (cable mode), or power bank in and Bluetooth on (wireless mode). Open the Prayoga app and choose this experiment. It opens the **Current and magnetic field** view and draws the live graph. It reads the current from the kit and the field from the phone's own magnetometer at the same time. Keep the phone flat and in the same spot.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Wind the wire into a flat bundle of 10 turns and tape one straight side to the table (10 turns give 10 times the field).
2. Open this experiment in the Prayoga app (it uses the phone's magnetometer). Place the phone 1 cm from the bundle. Note the reading with current off and on.
3. Repeat at 2, 3 and 4 cm.

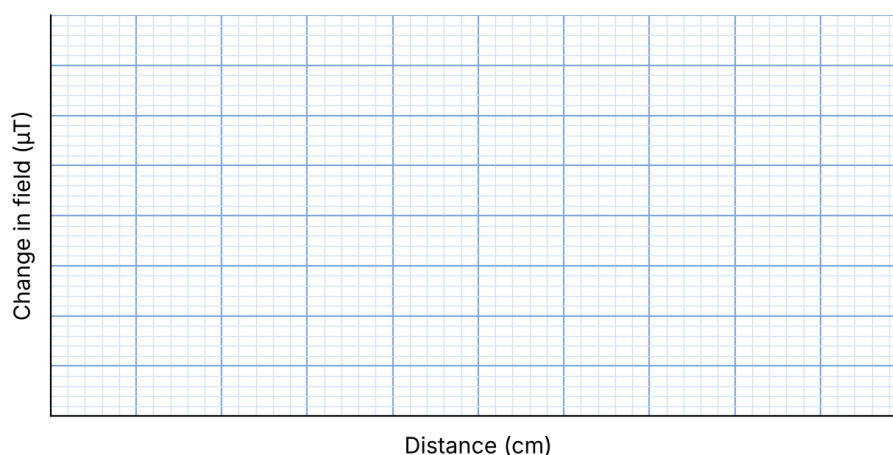
Write your readings in the table on the back.

3 Record your readings • Magnetic field around a wire

Distance (cm)	Current off (μT)	Current on (μT)	Change (μT)
1			
2			
3			
4			

3 Plot your results • Magnetic field around a wire

Plot your points by hand and draw the best line or smooth curve. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) What happens to the change in field when the distance doubles?

c) What happens to the reading if you reverse the battery? Why?

Exam-style questions

1. State the right-hand thumb rule. (2 marks)

2. Draw the magnetic field lines around a straight current-carrying conductor. (2 marks)

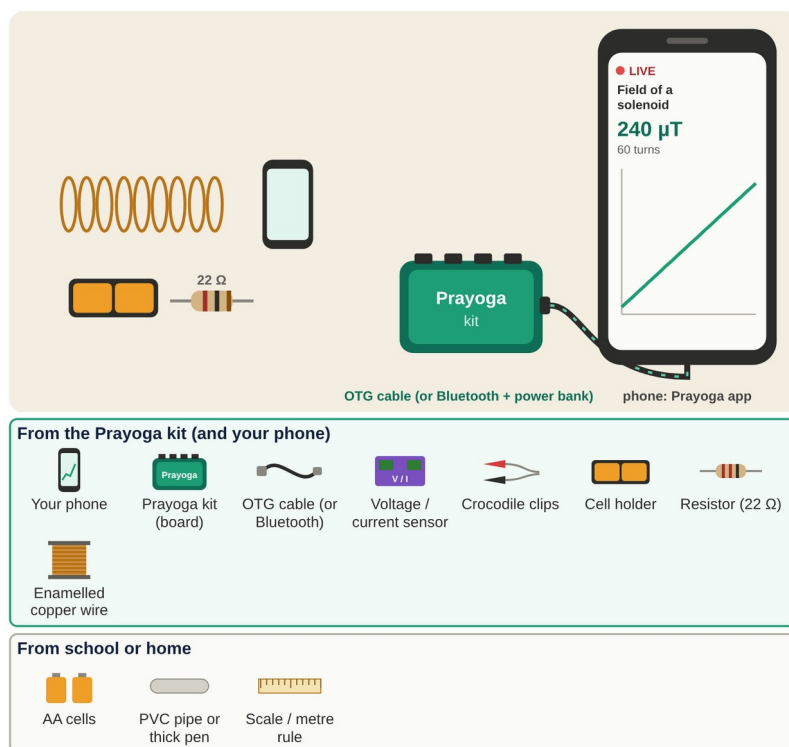
6. Field of a solenoid

Class 10 • Magnetic Effects of Electric Current **Basic kit + phone sensor**

Name _____ Class _____ Group _____ Date _____

You need: Prayoga kit, holder for 4 AA cells, 22 Ω resistor, 5 m of enamelled copper wire, a PVC pipe or thick pen, sandpaper, phone with the Prayoga app.

Safety: Keep the 22 Ω resistor in the circuit. Switch off between readings.

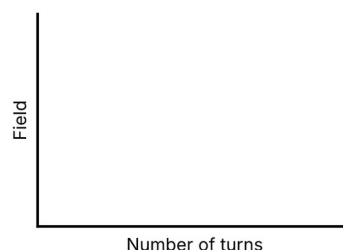


Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

Doubling the number of turns (same current, same length) will make the field: ☐ about double ☐ about half ☐ the same

Why do you think so?



Sketch the graph you expect

2 Measure by hand

- Count the turns carefully. Coil length with the scale: _____ cm. Keep the same length when you add turns (wind a second layer).

3 Set up Prayoga, then observe

Set up Prayoga

- Clip the circuit to the voltage/current sensor.
- Connect the kit: OTG cable to the phone (cable mode), or power bank in and Bluetooth on (wireless mode). Open the Prayoga app and choose this experiment. It opens the **Current and magnetic field** view and draws the live graph. It reads the current from the kit and the field from the phone's own magnetometer at the same time. Keep the phone flat and in the same spot.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

- Wind 20 turns on the pipe; sand the enamel off the ends.
- Hold the phone at a marked spot 1 cm from one end. Read the field with current off and on.
- Add turns to 40 and 60; repeat.

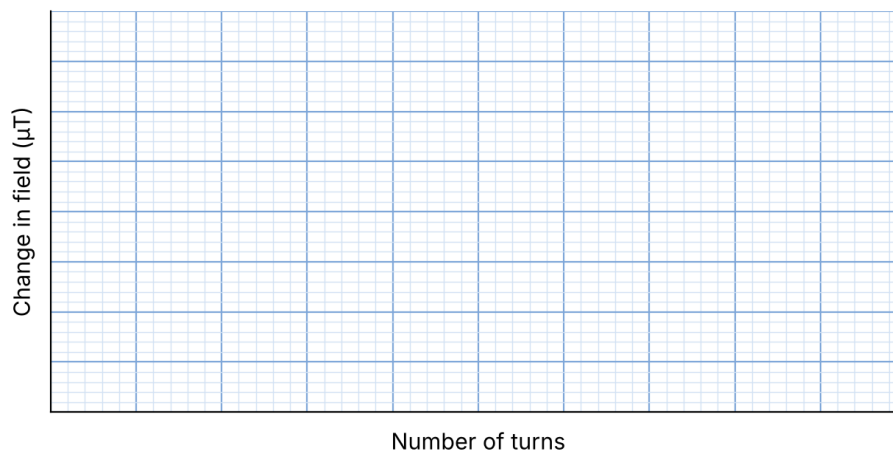
Write your readings in the table on the back.

3 Record your readings • Field of a solenoid

Turns	Current (mA)	Off (μT)	On (μT)	Change (μT)
20				
40				
60				

3 Plot your results • Field of a solenoid

Plot your points by hand and draw the best line or smooth curve. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) Is the field proportional to the number of turns?

c) Why must the current stay the same in every reading?

Exam-style questions

1. What is a solenoid? Draw the field lines of a current-carrying solenoid. (3 marks)

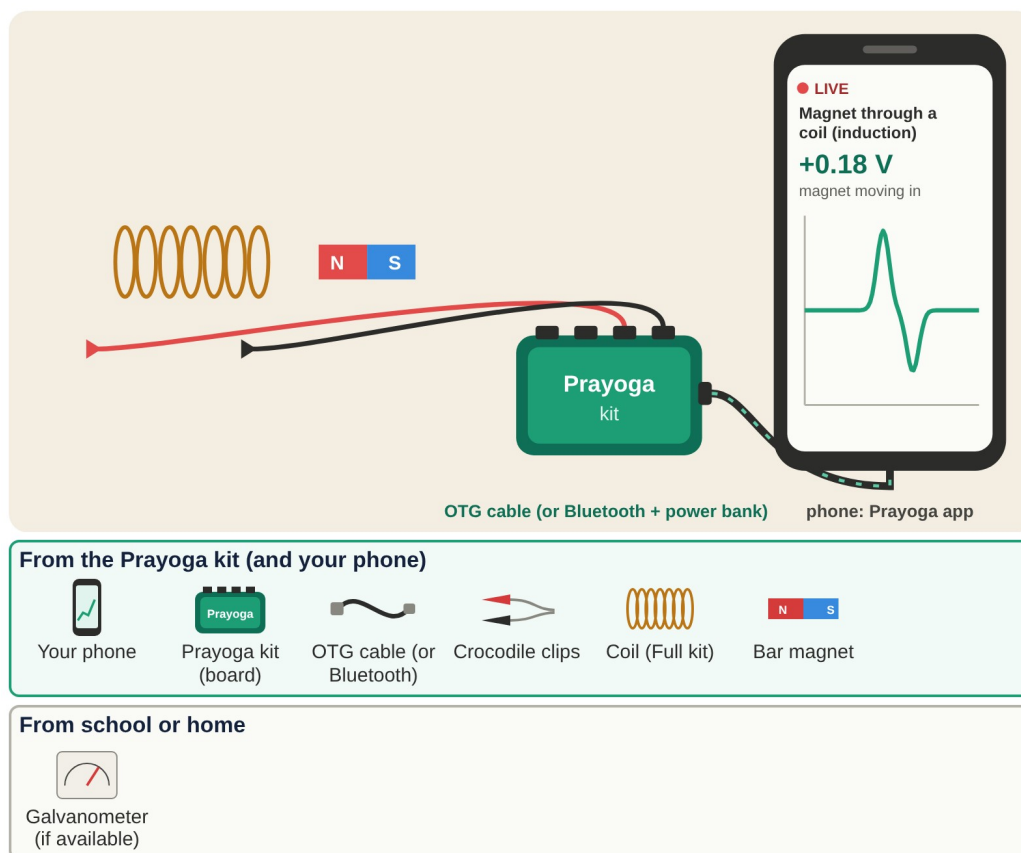
2. List two ways to make an electromagnet stronger. (2 marks)

7. Magnet through a coil (induction)

Class 10 • Magnetic Effects of Electric Current **Full kit**

Name _____ Class _____ Group _____ Date _____

You need: Coil of about 200 turns (Full kit), bar magnet, Prayoga kit; a galvanometer if your school has one.

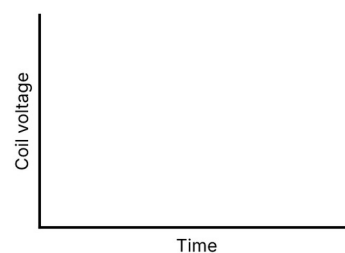


Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

When the magnet is pulled out instead of pushed in, the induced current will: ☐ flow the same way ☐ flow the opposite way ☐ not flow

Why do you think so?



Sketch the graph you expect

2 Measure by hand

- If your school has a galvanometer, connect the coil to it and note which way the needle moves for each action in the table.

3 Set up Prayoga, then observe

Set up Prayoga

- Connect the coil to the kit clips.
- Connect the kit: OTG cable to the phone (cable mode), or power bank in and Bluetooth on (wireless mode). Open the Prayoga app and choose this experiment. It opens the **Coil voltage** view and draws the live graph. It shows positive and negative spikes.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

- Connect the coil to the kit clips.
- Push the north pole in quickly, hold it still, then pull it out. Repeat slowly, then with the south pole.

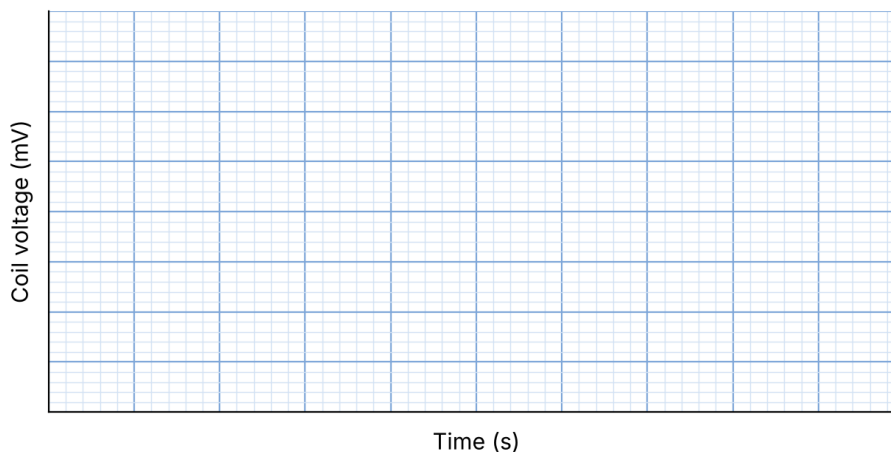
Write your readings in the table on the back.

3 Record your readings • Magnet through a coil (induction)

Action	Galvanometer (left / right / none)	Sensor peak (mV)
N pole in, fast		
Magnet held still		
N pole out, fast		
N pole in, slow		
S pole in, fast		

3 Plot your results • Magnet through a coil (induction)

Plot your points by hand and draw the best line or smooth curve. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) Why is there no reading when the magnet is still?

c) How does the speed of the magnet change the peak?

Exam-style questions

1. What is electromagnetic induction? (2 marks)

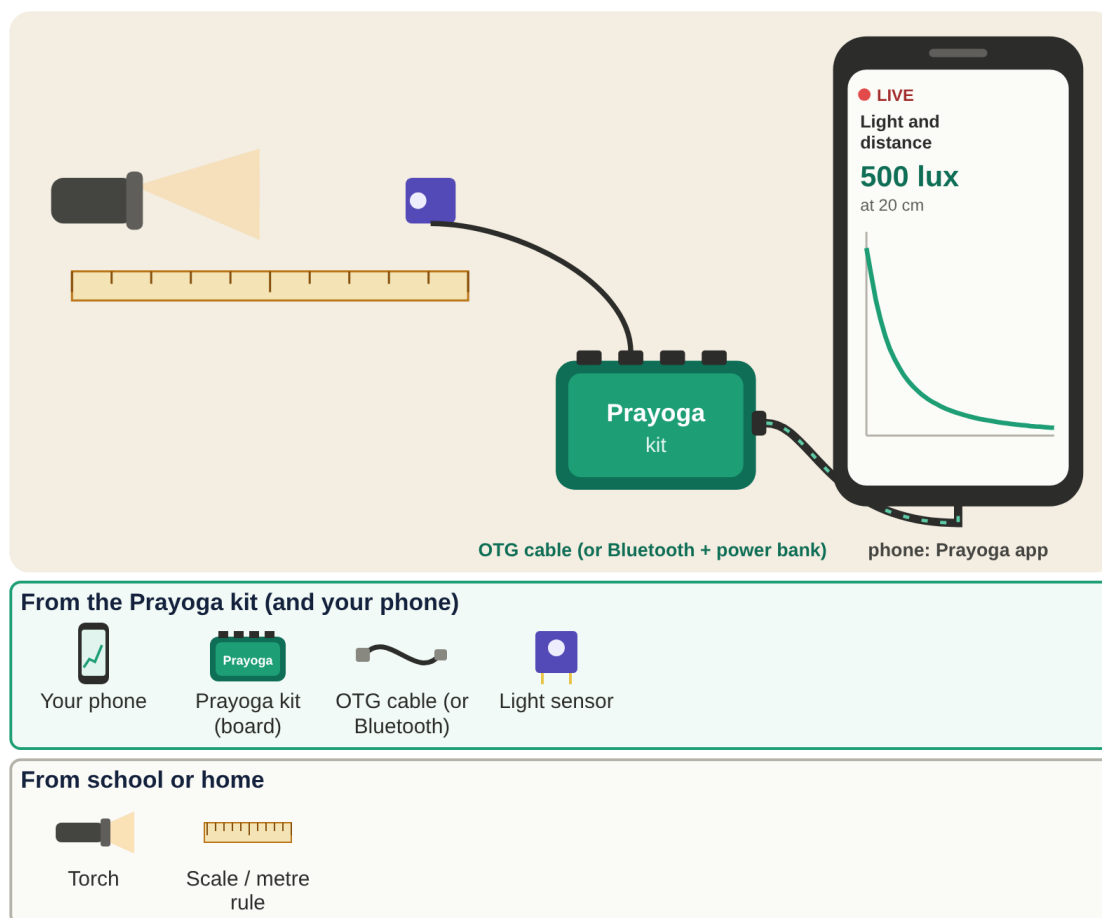
2. State Fleming's right-hand rule. (2 marks)

8. Light and distance

Class 10 (graph skills) • Light **Basic kit**

Name _____ Class _____ Group _____ Date _____

You need: Prayoga kit (light sensor), small LED torch or phone torch, metre scale, a dark corner.

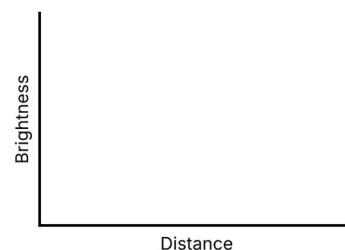


Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

Moving the sensor from 10 cm to 20 cm from the torch, the brightness will become about: ☐ half ☐ one quarter ☐ the same

Why do you think so?



Sketch the graph you expect

2 Measure by hand

1. Metre scale least count: _____ cm. Measure from the front of the torch bulb to the face of the sensor.

3 Set up Prayoga, then observe

Set up Prayoga

- Plug in the light sensor and point it at the light source.
- Connect the kit: OTG cable to the phone (cable mode), or power bank in and Bluetooth on (wireless mode). Open the Prayoga app and choose this experiment. It opens the **Light** view and draws the live graph.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Keep the sensor facing the torch squarely, at the same height.
2. Start recording in the app. Record brightness at each distance and work out brightness $\times d^2$.

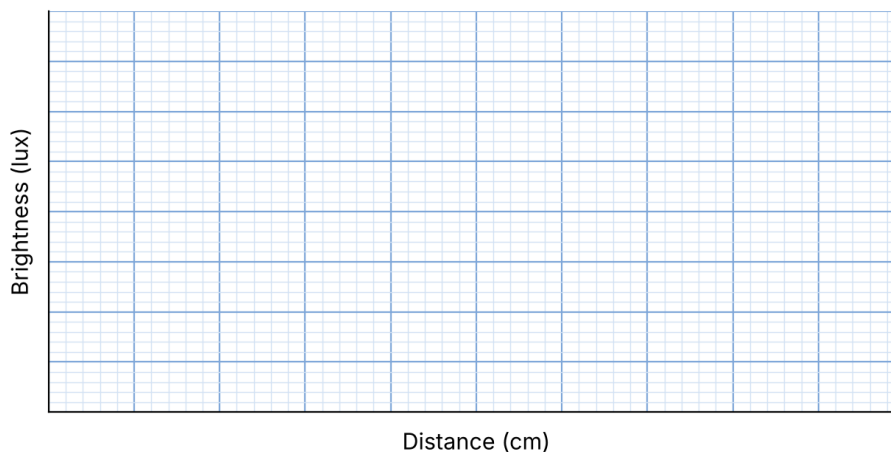
Write your readings in the table on the back.

3 Record your readings • Light and distance

Distance d (cm)	Brightness (lux)	d^2 (cm ²)	Brightness $\times d^2$
10		100	
15		225	
20		400	
30		900	
40		1600	

3 Plot your results • Light and distance

Plot your points by hand and draw the best line or smooth curve. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) Is the graph a straight line? Describe its shape.

c) What do you notice in the last column? What does it tell you?

Exam-style questions

1. From your graph, estimate the brightness at 25 cm. (1 mark)

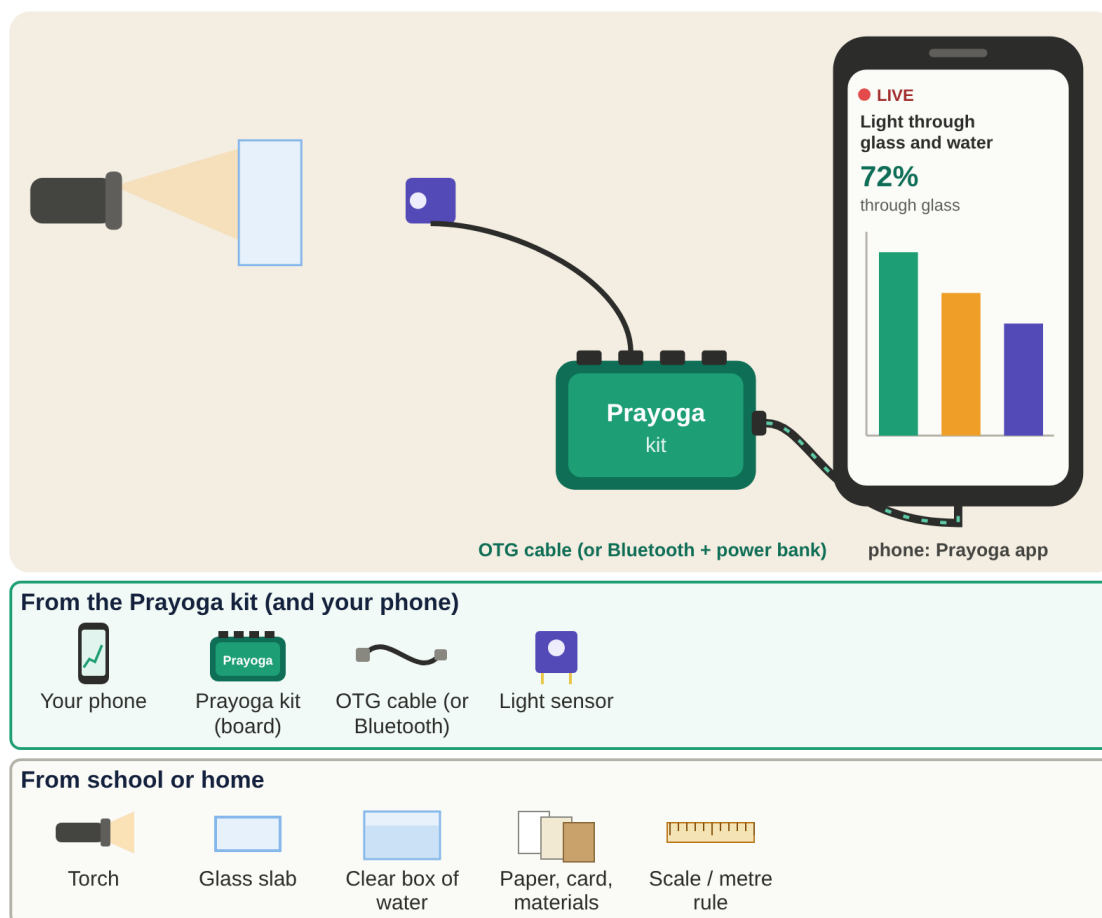
2. A lamp is moved from 1 m to 50 cm from a book. About how many times brighter is the book? Explain. (2 marks)

9. Light through glass and water

Class 10 • Light: Reflection and Refraction **Basic kit**

Name _____ Class _____ Group _____ Date _____

You need: Prayoga kit (light sensor), LED torch, glass slab (two if possible), clear plastic box of water, sheet of paper, scale.



Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

Rank before testing (1 = lets most light through): glass slab _____ box of water _____ paper _____

Why do you think so?

2 Measure by hand

1. Measure the thickness of the glass slab: _____ cm, and the width of the water box: _____ cm.

3 Set up Prayoga, then observe

Set up Prayoga

- Plug in the light sensor and point it at the light source.
- Connect the kit: OTG cable to the phone (cable mode), or power bank in and Bluetooth on (wireless mode). Open the Prayoga app and choose this experiment. It opens the **Light** view and draws the live graph.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Fix the torch 20 cm from the sensor. Note the reading with nothing between (this is 100%).
2. Put each material between them, in the same place. Work out the percentage.

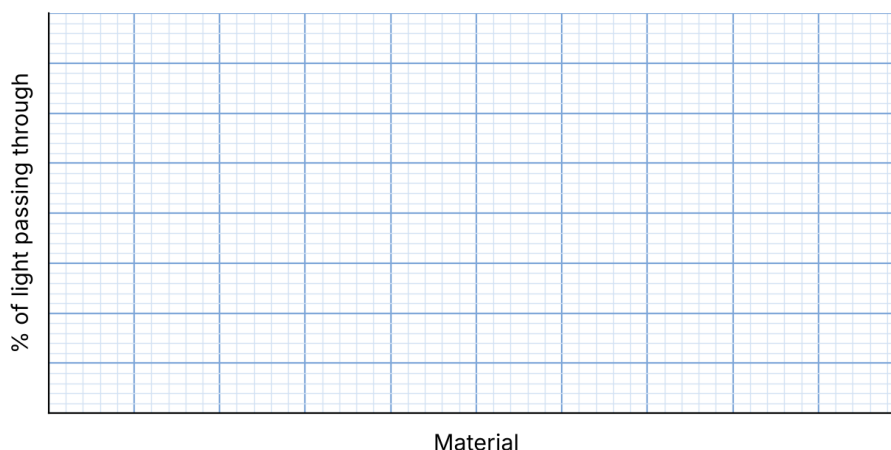
Write your readings in the table on the back.

3 Record your readings · Light through glass and water

Material	Brightness (lux)	% = lux ÷ air reading × 100
Nothing (air)		100
One glass slab		
Two glass slabs		
Box of water		
Paper		

3 Plot your results · Light through glass and water

Draw a bar chart by hand. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) Which material blocked the most light? Give two reasons light is lost (think about the surfaces).

c) Did two slabs block twice as much as one?

Exam-style questions

1. Define refraction of light. (1 mark)

2. The refractive index of glass is 1.5. What does this mean? (2 marks)

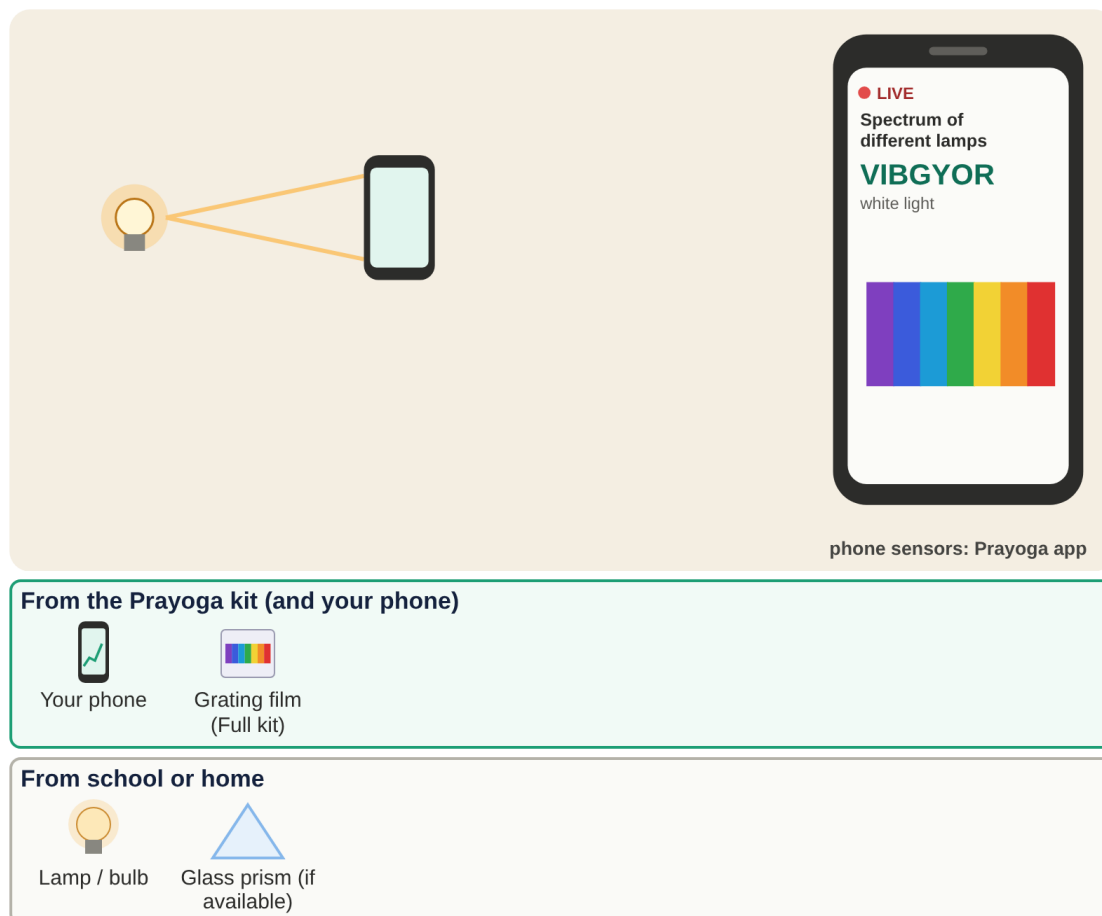
10. Spectrum of different lamps

Class 10 • Human Eye and the Colourful World **Full kit**

Name _____ Class _____ Group _____ Date _____

You need: Diffraction grating film, phone camera, filament bulb, LED or tube light, a window with sky (never the sun); glass prism if your school has one.

Safety: Never look at the sun, directly or through the film.



Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

Which colour bends the most when white light passes through a prism? ☐ red ☐ green ☐ violet

Why do you think so?

2 Measure by hand

1. With a glass prism, make a spectrum on white paper in a sunny window. Write the order of colours:

3 Set up Prayoga, then observe

Set up Prayoga

- Fit the grating film over the main camera with its clip.
- Open the Prayoga app and choose this experiment. The **Spectrum** view shows the colours and saves a photo of each lamp.

1. Tape the grating film over the phone camera.
2. Photograph the spectrum of each light source. Compare the colours and whether they form a smooth band or separate lines.

Write your readings in the table on the back.

3 Record your readings · Spectrum of different lamps

Light source	Colours seen (in order)	Smooth band or separate lines?
Filament bulb		
LED or tube light		
Daylight (sky)		
Phone screen (white)		

4 Explain

a) Was your prediction right? If not, what changed your mind?

b) Which sources give a smooth rainbow, and which give separate bands?

c) Why does a prism split white light into colours?

Exam-style questions

1. What is dispersion of white light? (1 mark)

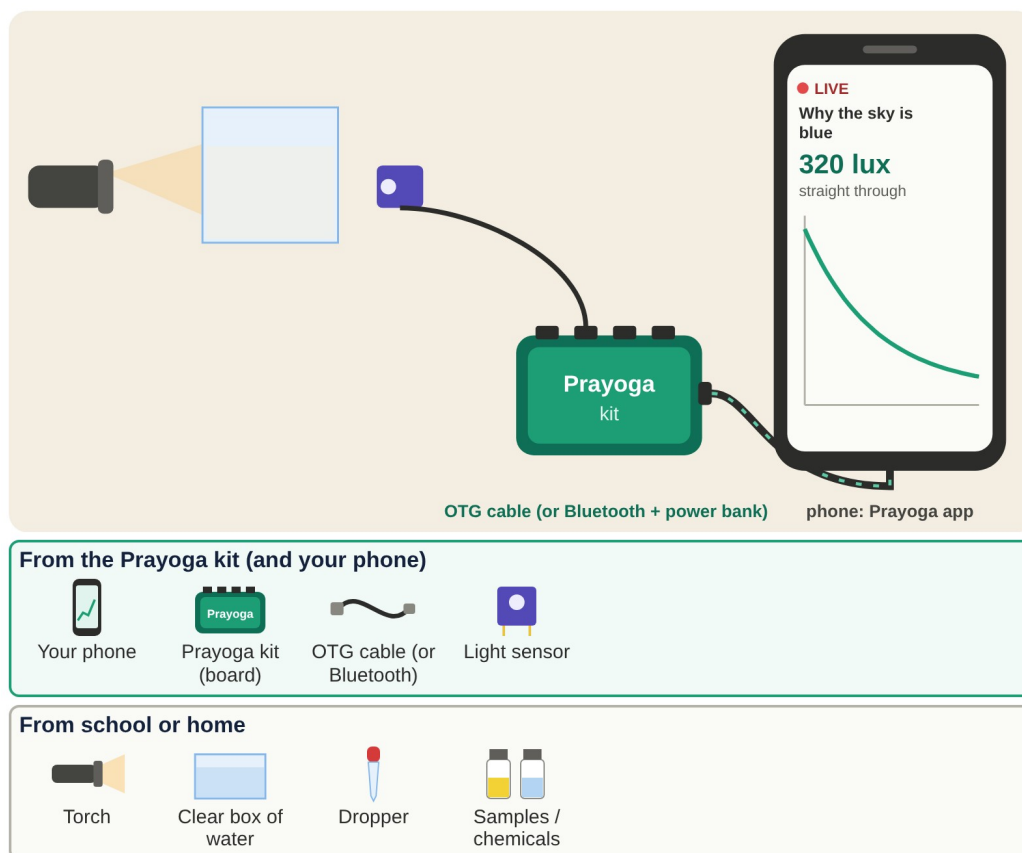
2. Draw a labelled diagram showing dispersion of white light by a glass prism. (3 marks)

11. Why the sky is blue

Class 10 • Human Eye and the Colourful World **Basic kit**

Name _____ Class _____ Group _____ Date _____

You need: Prayoga kit (light sensor), white LED torch, clear plastic box of water, milk, dropper, white card.

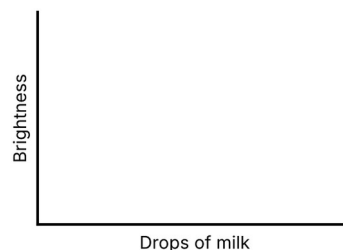


Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

As milk is added, the light going straight through will: ☐ increase ☐ decrease ☐ stay the same

Why do you think so?



Sketch the graph you expect

2 Measure by hand

- Count drops exactly and stir the same way each time, so each step adds the same amount.

3 Set up Prayoga, then observe

Set up Prayoga

- Plug in the light sensor and point it at the light source.
- Connect the kit: OTG cable to the phone (cable mode), or power bank in and Bluetooth on (wireless mode). Open the Prayoga app and choose this experiment. It opens the **Light** view and draws the live graph.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

- Shine the torch through the long side of the box. Put the sensor opposite (straight through) and take a second reading from the side.
- Add 5 drops of milk at a time and stir. Look at the colour from the side and from the far end.

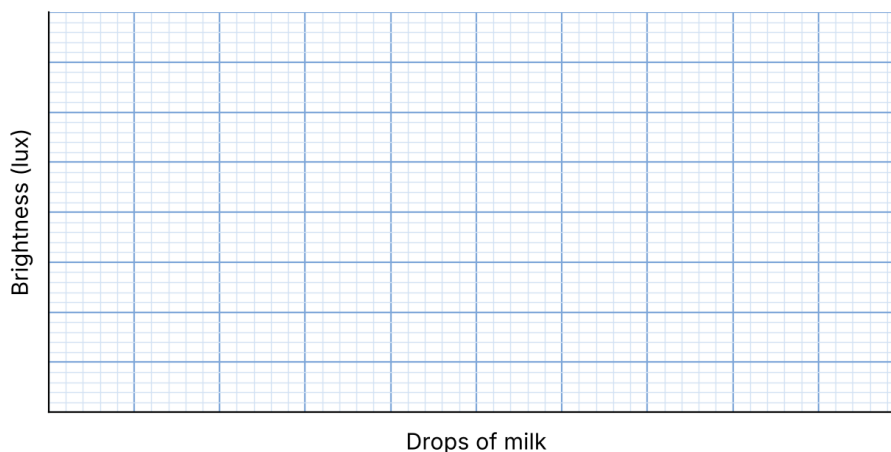
Write your readings in the table on the back.

3 Record your readings • Why the sky is blue

Drops of milk	Straight through (lux)	From the side (lux)	Colour seen from the side / the end
0			
5			
10			
15			
20			

3 Plot your results • Why the sky is blue

Plot your points by hand and draw the best line or smooth curve. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) Explain the colours seen from the side and from the end.

c) Use your result to explain why the sun looks red at sunset.

Exam-style questions

1. Why does the clear sky appear blue? (2 marks)

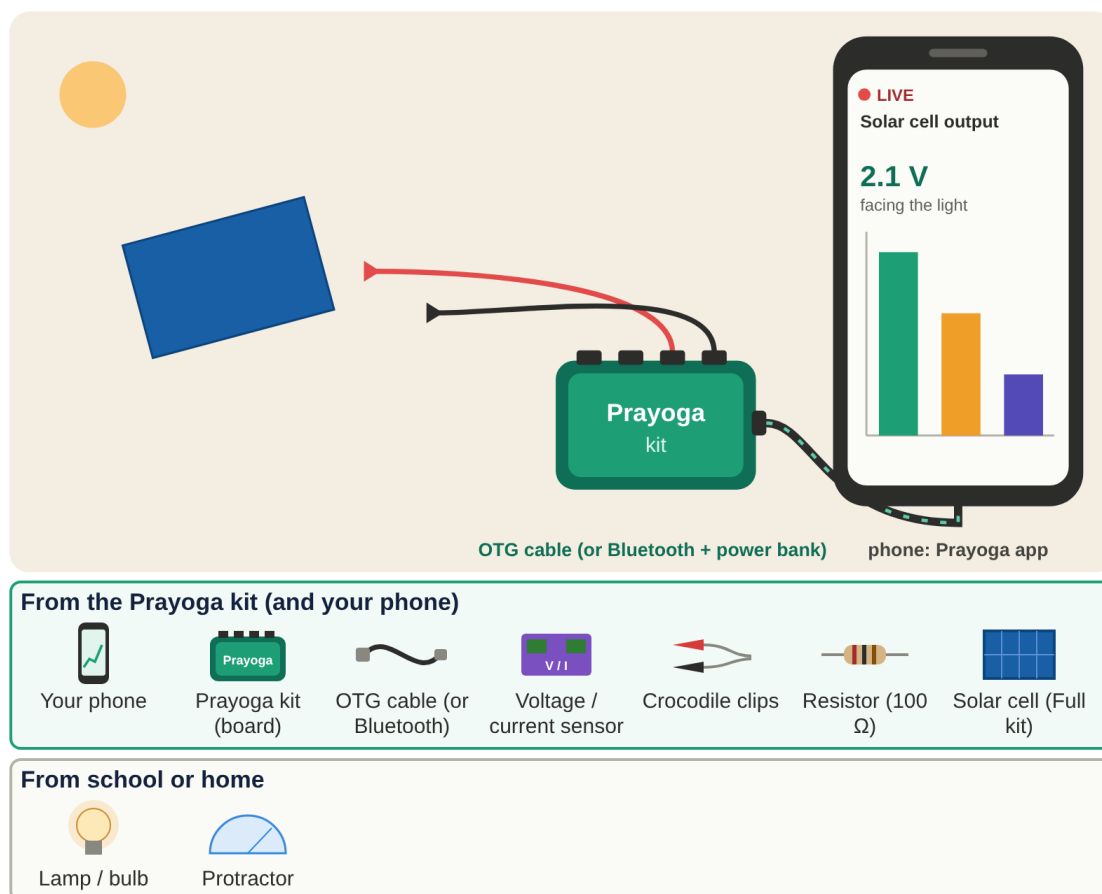
2. Why are danger signals red? (2 marks)

12. Solar cell output

Class 10 • Sources of Energy **Full kit**

Name _____ Class _____ Group _____ Date _____

You need: Prayoga kit, small solar cell, 100 Ω resistor, lamp or sunlight, protractor, card.



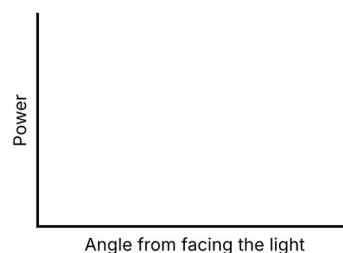
Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

Covering half the solar cell will make its output: ☐ about half ☐ zero

☐ unchanged

Why do you think so?



Sketch the graph you expect

2 Measure by hand

1. Use the protractor to set the cell at 0°, 30°, 60° and 90° from facing the light.

3 Set up Prayoga, then observe

Set up Prayoga

- Connect the solar cell: + $\rightarrow$ VIN+; VIN- $\rightarrow$ 100 Ω resistor $\rightarrow$ solar cell - and kit GND.
- Connect the kit: OTG cable to the phone (cable mode), or power bank in and Bluetooth on (wireless mode). Open the Prayoga app and choose this experiment. It opens the **Solar cell** view and draws the live graph. It shows voltage, current and power.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Solar cell + $\rightarrow$ VIN+; VIN- $\rightarrow$ 100 Ω resistor $\rightarrow$ solar cell - and kit GND.
2. Record V and I at each angle and when half covered. Power (mW) = $V \times I$ (mA).

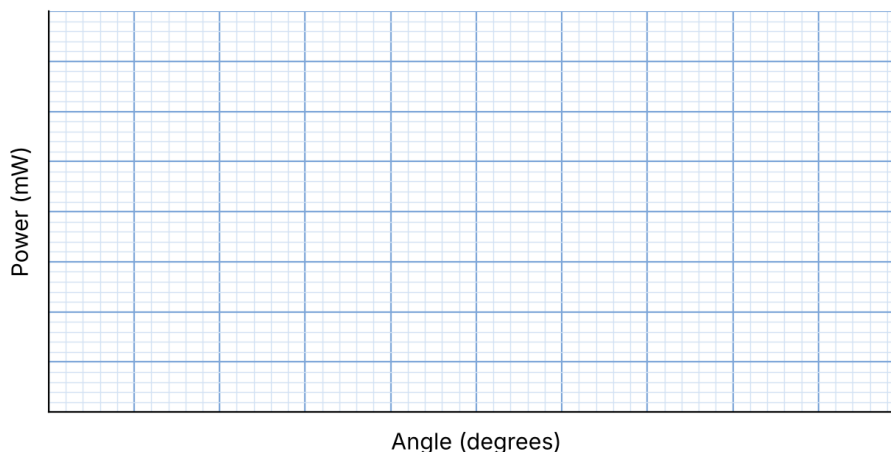
Write your readings in the table on the back.

3 Record your readings • Solar cell output

Condition	V (V)	I (mA)	Power (mW)
Facing light (0°)			
30°			
60°			
90°			
Half covered			

3 Plot your results • Solar cell output

Plot your points by hand and draw the best line or smooth curve. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) At what angle is the output largest? Why?

c) How should solar panels on a school roof in Karnataka be placed?

Exam-style questions

1. Give two advantages and one limitation of solar cells. (3 marks)

2. What is a solar panel? (1 mark)

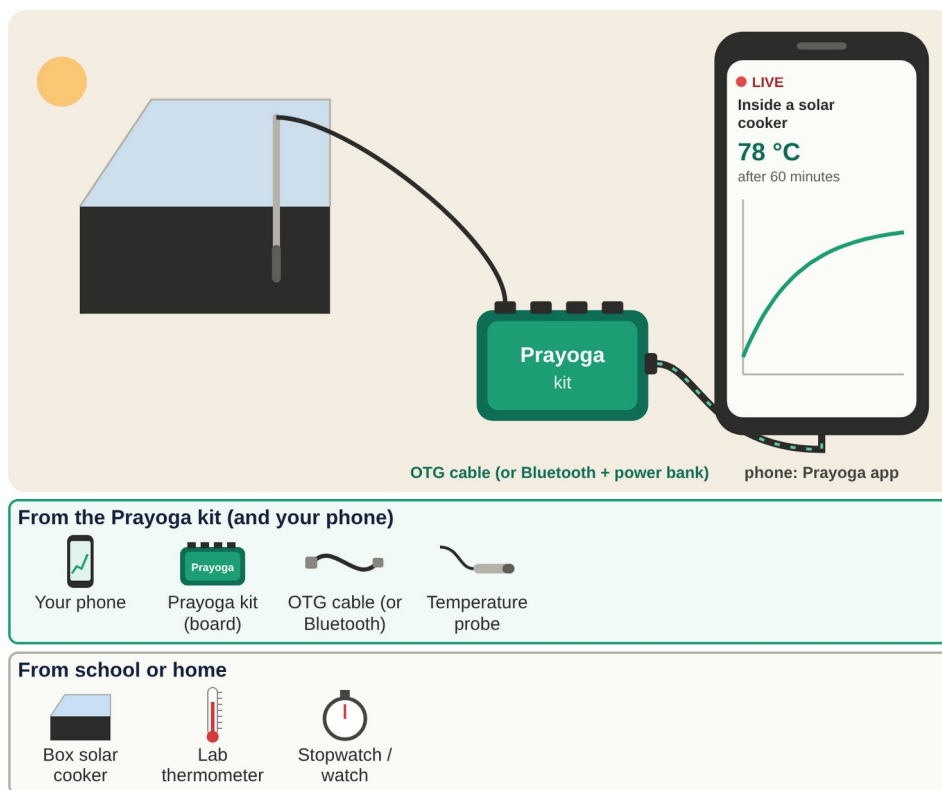
13. Inside a solar cooker

Class 10 • Sources of Energy **Basic kit**

Name _____ Class _____ Group _____ Date _____

You need: Prayoga kit (temperature probe), lab thermometer, box solar cooker (box painted black inside, glass or plastic lid, foil reflector), a sunny day.

Safety: The inside gets hot. Use a cloth to open the lid.

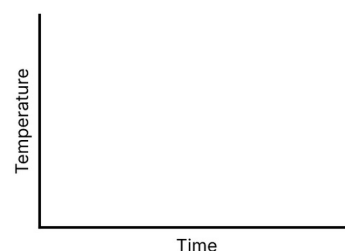


Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

After an hour in the sun, the inside of the cooker will be: ☐ about the same as the air ☐ a little warmer ☐ much hotter

Why do you think so?



Sketch the graph you expect

2 Measure by hand

1. Read the air temperature in the shade with the lab thermometer every 10 minutes.

3 Set up Prayoga, then observe

Set up Prayoga

- Plug the temperature probe into the kit.
- Connect the kit: OTG cable to the phone (cable mode), or power bank in and Bluetooth on (wireless mode). Open the Prayoga app and choose this experiment. It opens the **Temperature** view and draws the live graph. Check it shows room temperature before you start.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Put the probe inside the cooker and close the lid. Face the cooker and reflector to the sun.
2. Record both temperatures every 10 minutes for an hour.

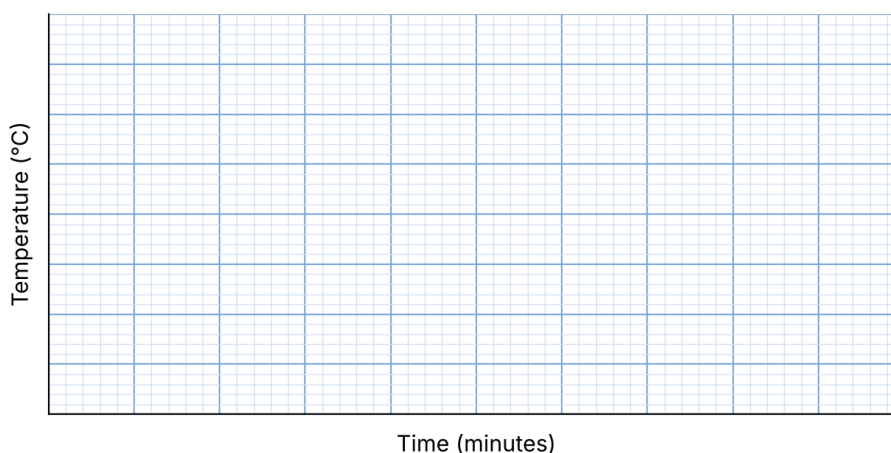
Write your readings in the table on the back.

3 Record your readings • Inside a solar cooker

Time (min)	Inside cooker (°C, sensor)	Air in shade (°C, thermometer)
0		
10		
20		
30		
40		
50		
60		

3 Plot your results • Inside a solar cooker

Plot your points by hand and draw the best line or smooth curve. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) Why is the inside painted black?

c) What does the glass lid do?

Exam-style questions

1. Why is a solar cooker painted black inside? (1 mark)

2. Give two limitations of a box-type solar cooker. (2 marks)

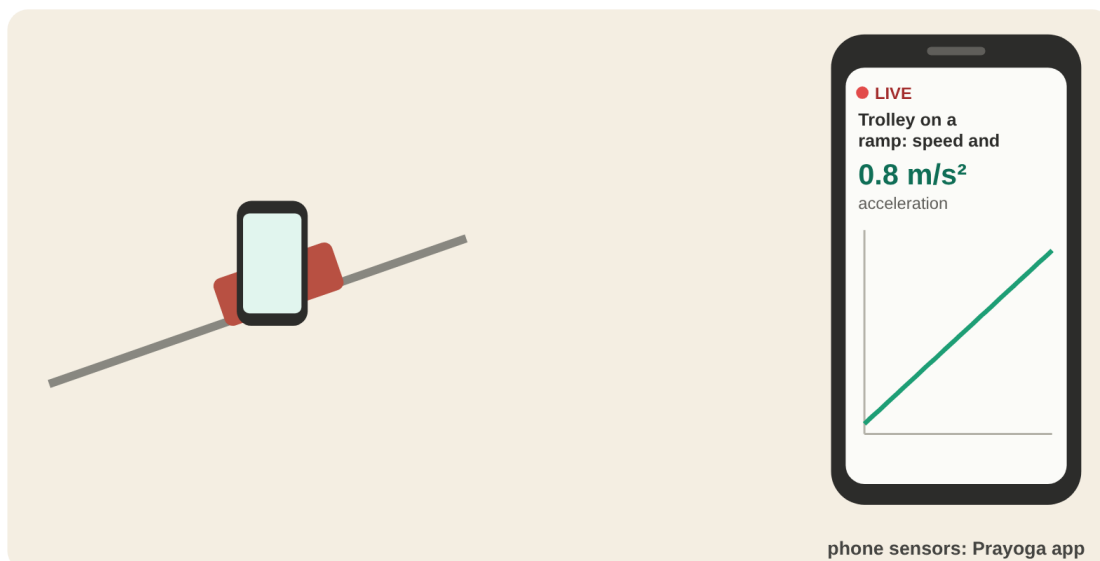
14. Trolley on a ramp: speed and acceleration

Class 9 • Motion **Phone only (Prayoga app)**

Name _____ Class _____ Group _____ Date _____

You need: Phone with the Prayoga app, toy trolley or skateboard, a plank and books for a ramp, metre scale, stopwatch, tape.

Safety: Put a cushion at the bottom of the ramp to catch the phone.



From the Prayoga kit (and your phone)



Your phone

From school or home



Toy trolley +
ramp



Plank + books
(ramp)



Scale / metre
rule



Stopwatch /
watch

Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

As the trolley rolls down the ramp, its speed will: ☐ stay the same ☐ increase steadily ☐ increase then decrease

Why do you think so?



Sketch the graph you expect

2 Measure by hand

1. Ramp length: _____ m. Time the roll from rest with a stopwatch (3 tries); use the average.

3 Set up Prayoga, then observe

Set up Prayoga

- No kit needed. Open the Prayoga app and choose this experiment. It opens the **Acceleration** view using the phone's accelerometer. Tape the phone firmly, screen up, long side along the motion.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Tape the phone on the trolley. Open this experiment in the Prayoga app (it uses the phone's accelerometer).
2. Release from rest and read the acceleration along the ramp. Repeat with the ramp on 2, 4 and 6 books.

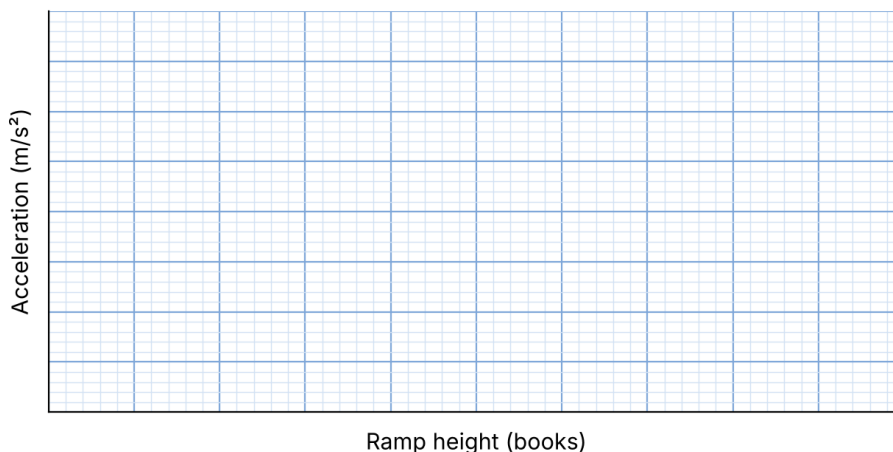
Write your readings in the table on the back.

3 Record your readings • Trolley on a ramp: speed and acceleration

Ramp height (books)	Time by stopwatch (s)	$a = 2 \times \text{length} \div t^2$ (m/s ²)	a from phone (m/s ²)
2			
4			
6			

3 Plot your results • Trolley on a ramp: speed and acceleration

Plot your points by hand and draw the best line or smooth curve. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) Does your stopwatch value of a match the phone? Give one reason for any difference.

c) Why does a steeper ramp give more acceleration?

Exam-style questions

1. A trolley starts from rest and reaches 2 m/s in 4 s. Find its acceleration. (2 marks)

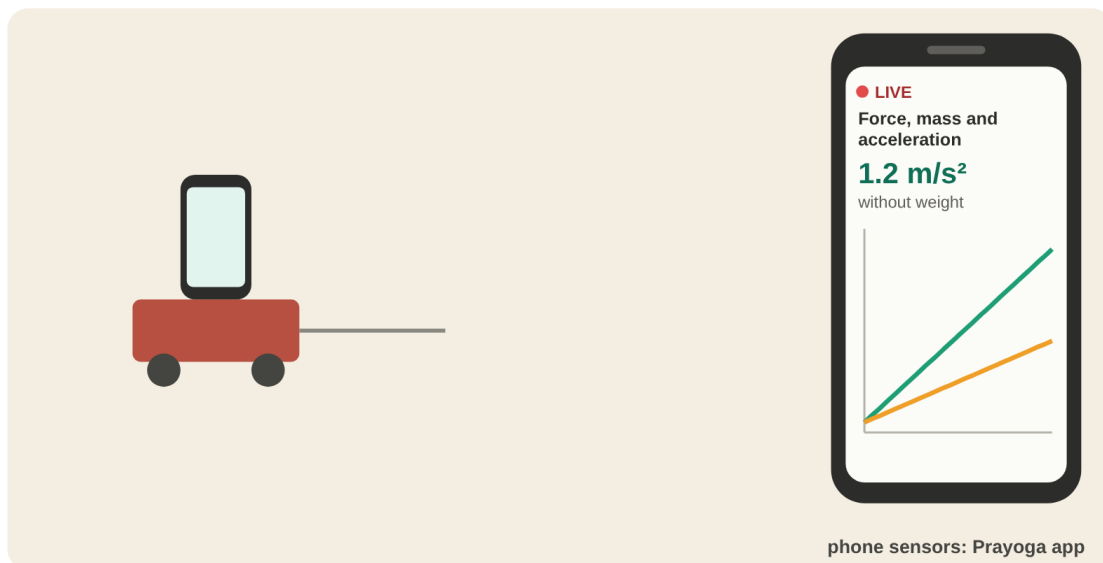
2. Draw the velocity–time graph of a body moving with uniform acceleration. (2 marks)

15. Force, mass and acceleration

Class 9 • Force and Laws of Motion **Phone only (Prayoga app)**

Name _____ Class _____ Group _____ Date _____

You need: Phone with the Prayoga app, toy trolley, rubber band, two filled water bottles as extra mass, kitchen scale, scale.



From the Prayoga kit (and your phone)



Your phone

From school or home



Toy trolley +
ramp



Flasks / bottles



Kitchen scale

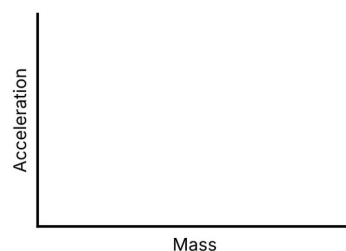
Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

Same pull, double the mass: the acceleration will ☐ double ☐ halve

☐ stay the same

Why do you think so?



Sketch the graph you expect

2 Measure by hand

1. Weigh the trolley with the phone, and each bottle, on the kitchen scale: trolley + phone _____ g, bottle _____ g.

3 Set up Prayoga, then observe

Set up Prayoga

- No kit needed. Open the Prayoga app and choose this experiment. It opens the **Acceleration** view using the phone's accelerometer. Tape the phone firmly, screen up, long side along the motion.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Pull the trolley with the rubber band stretched to the same mark every time. Read the largest acceleration.
2. Add one bottle, then two; repeat.

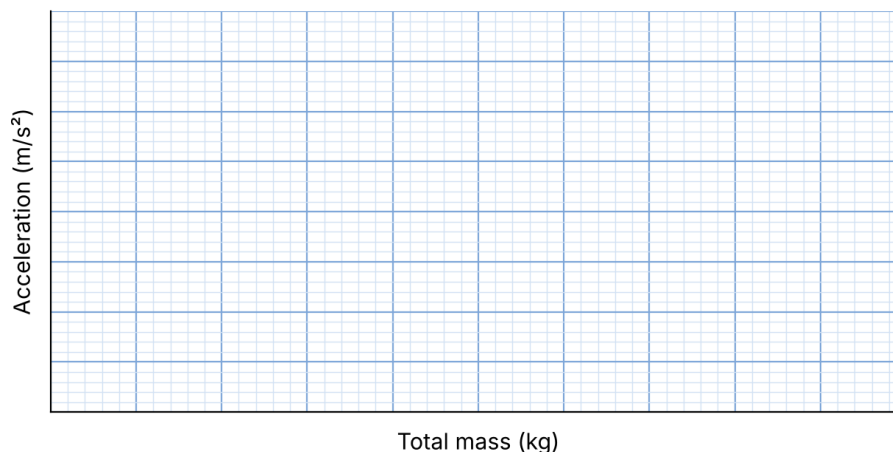
Write your readings in the table on the back.

3 Record your readings • Force, mass and acceleration

Total mass (kg)	Acceleration (m/s^2)	Mass $\times$ acceleration (N)
Trolley + phone		
+ 1 bottle		
+ 2 bottles		

3 Plot your results • Force, mass and acceleration

Plot your points by hand and draw the best line or smooth curve. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) Is mass $\times$ acceleration about the same each time? What does it stand for?

c) Why must the band be stretched to the same mark every time?

Exam-style questions

1. State Newton's second law of motion. (2 marks)

2. A force of 10 N acts on a 2 kg mass. Find its acceleration. (1 mark)

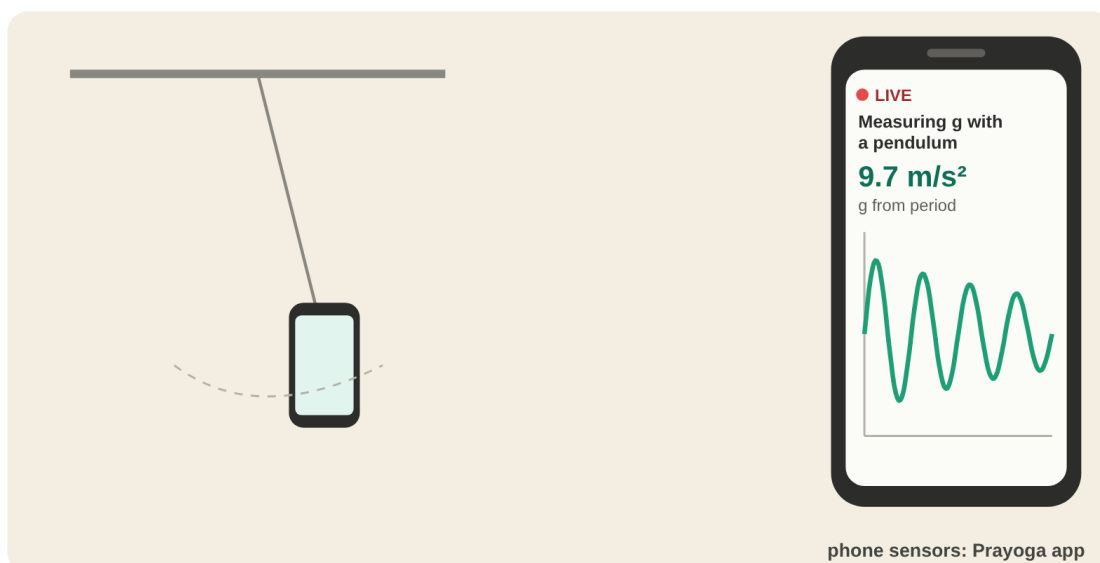
16. Measuring g with a pendulum

Class 9 • Gravitation **Phone only (Prayoga app)**

Name _____ Class _____ Group _____ Date _____

You need: Phone in a pouch, strong string, a hook or rod, metre scale, stopwatch, cushion.

Safety: Tie the string firmly and swing over a cushion. Keep swings small.



From the Prayoga kit (and your phone)



Your phone

From school or home



String + pouch



Scale / metre rule



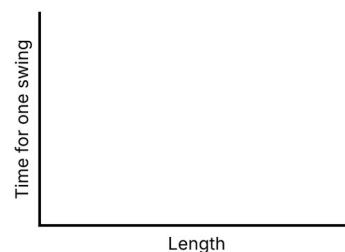
Stopwatch / watch

Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

A longer string will make each swing: ☐ quicker ☐ slower ☐ the same

Why do you think so?



Sketch the graph you expect

2 Measure by hand

- Time 10 swings with a stopwatch for each length; one swing $T = \text{time} \div 10$. Measure L from the hook to the middle of the phone.

3 Set up Prayoga, then observe

Set up Prayoga

- No kit needed. Open the Prayoga app and choose this experiment. It opens the **Pendulum** view using the phone's motion sensors. Enter the string length, put the phone in the pouch, then start.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

- Hang the phone. Open this experiment in the Prayoga app and enter the length.
- Swing gently (less than 10°). Read the period and g . Repeat at 0.50, 0.75 and 1.00 m.

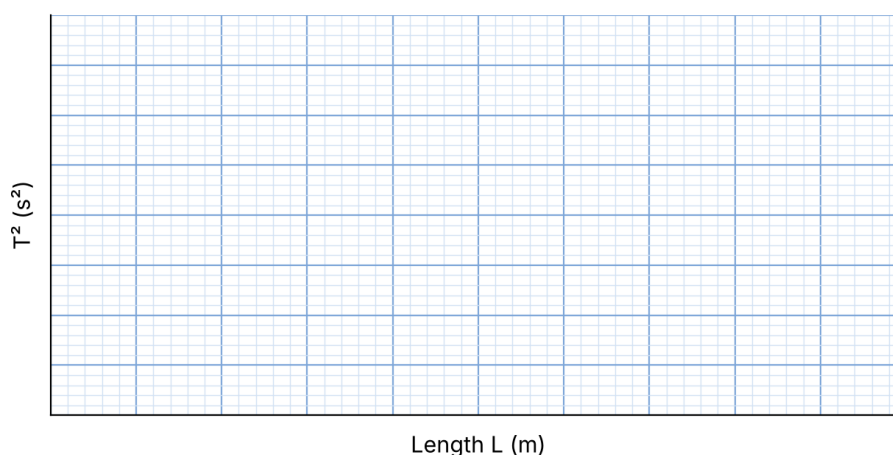
Write your readings in the table on the back.

3 Record your readings • Measuring g with a pendulum

L (m)	10 swings by stopwatch (s)	T by hand (s)	T by phone (s)	$g = 4\pi^2 L \div T^2$ (m/s ²)
0.50				
0.75				
1.00				

3 Plot your results • Measuring g with a pendulum

Plot your points by hand and draw the best line or smooth curve. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) Is your graph of T^2 against L a straight line through zero?

c) Why time 10 swings instead of one?

Exam-style questions

1. What is the value of g on the surface of the Earth? (1 mark)

2. Why is g on the Moon smaller than on the Earth? (2 marks)

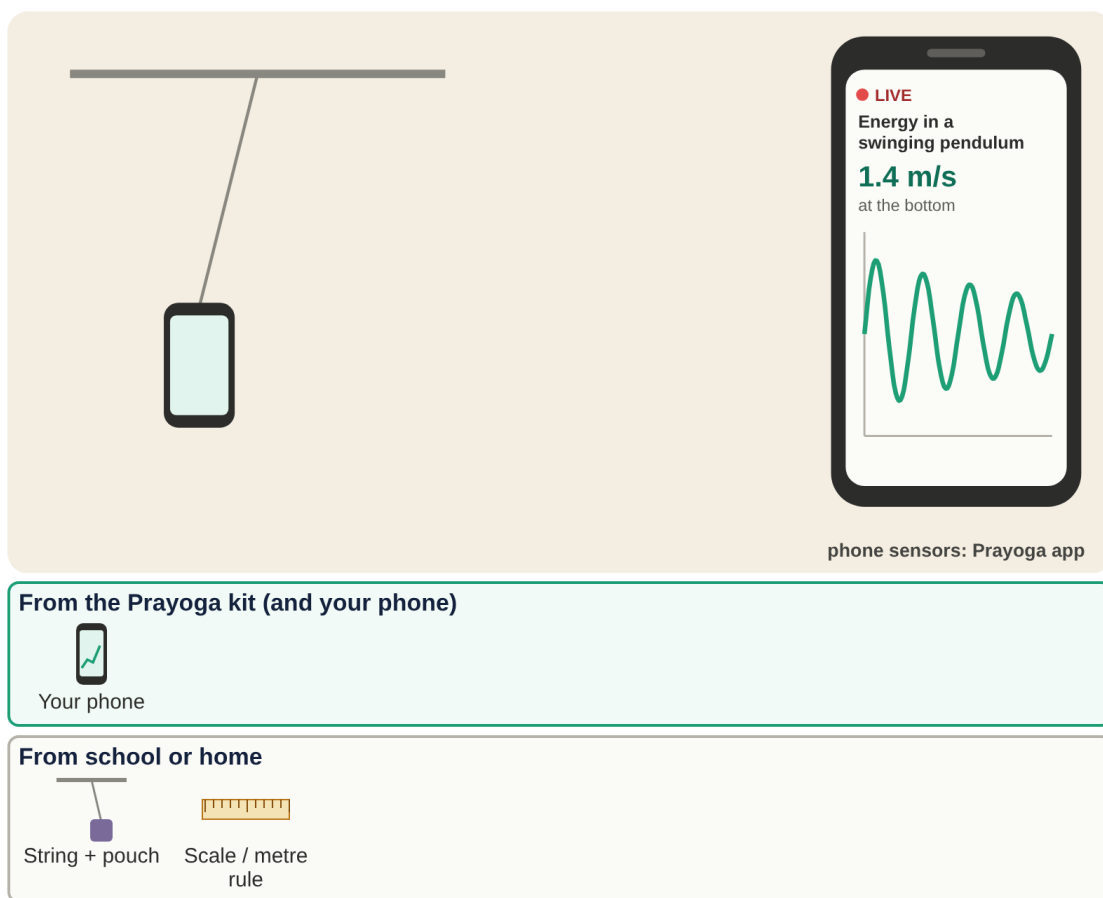
17. Energy in a swinging pendulum

Class 9 • Work and Energy **Phone only (Prayoga app)**

Name _____ Class _____ Group _____ Date _____

You need: Phone pendulum from the previous worksheet ($L = 1\text{ m}$), scale, cushion.

Safety: Swing over a cushion. Keep release heights small.



Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

Releasing from twice the height, the speed at the bottom will be: ☐ double ☐ about 1.4 times ☐ the same

Why do you think so?

2 Measure by hand

1. Measure the release height h above the lowest point of the swing with a scale.

3 Set up Prayoga, then observe

Set up Prayoga

- No kit needed. Open the Prayoga app and choose this experiment. It opens the **Rotation** view using the phone's gyroscope. Put the phone in the pouch so it swings flat.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Open this experiment in the Prayoga app (it uses the phone's gyroscope). Release from heights of 5, 10 and 20 cm.
2. Read the largest rotation speed ω (rad/s). Speed at the bottom $v = \omega \times L$.

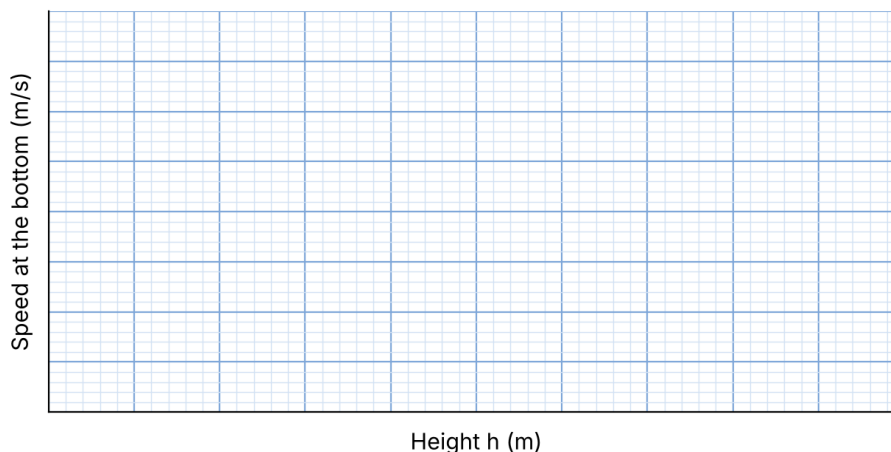
Write your readings in the table on the back.

3 Record your readings • Energy in a swinging pendulum

h (m)	ω largest (rad/s)	$v = \omega \times L$ (m/s)	v predicted = $\sqrt{2gh}$ (m/s)
0.05			
0.10			
0.20			

3 Plot your results • Energy in a swinging pendulum

Plot your points by hand and draw the best line or smooth curve. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) Do measured and predicted speeds match? Where did the missing energy go?

c) Where in the swing is kinetic energy largest? Where is potential energy largest?

Exam-style questions

1. State the law of conservation of energy. (1 mark)

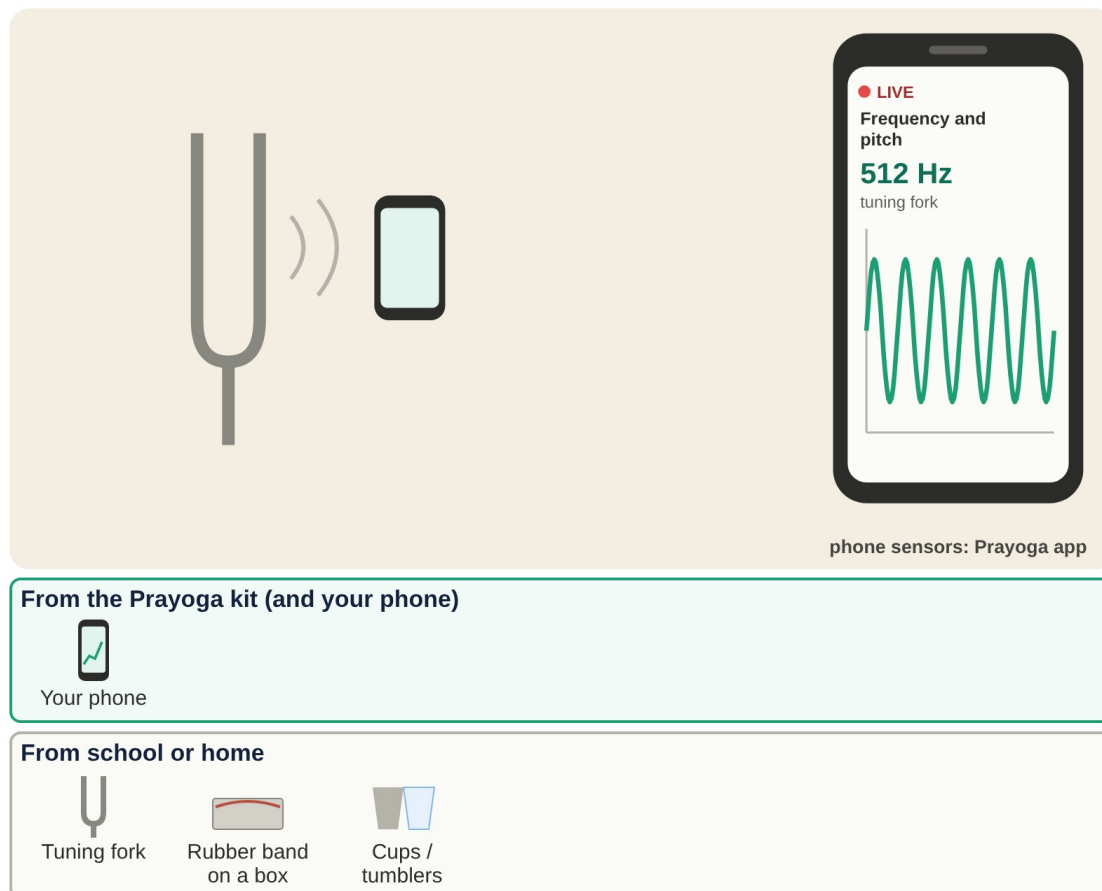
2. A 0.2 kg ball falls from 5 m. Find its kinetic energy just before it hits the ground ($g = 10 \text{ m/s}^2$). (2 marks)

18. Frequency and pitch

Class 9 • Sound **Phone only (Prayoga app)**

Name _____ Class _____ Group _____ Date _____

You need: Phone with the Prayoga app, tuning forks if available, a rubber band stretched over an open box, two steel glasses with different amounts of water.



Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

A higher-pitched sound has a: ☐ higher frequency ☐ lower frequency ☐ bigger amplitude

Why do you think so?

2 Measure by hand

1. Read the frequency stamped on each tuning fork: _____ Hz and _____ Hz.

3 Set up Prayoga, then observe

Set up Prayoga

- No kit needed. Open the Prayoga app and choose this experiment. It opens the **Sound frequency** view using the phone's microphone. Hold it 20–30 cm from the sound in a quiet room.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Open this experiment in the Prayoga app (it uses the phone's microphone). Strike a fork near the microphone and read the peak frequency.
2. Pluck the rubber band loose and tight; tap each glass. Record the frequency.

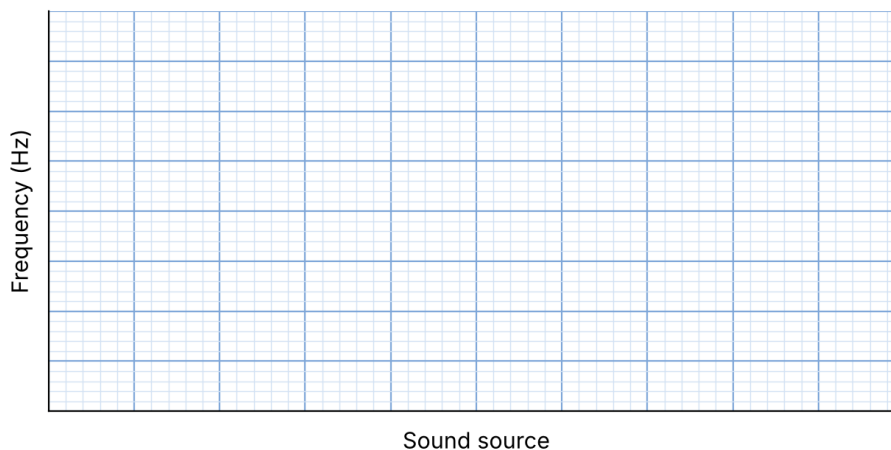
Write your readings in the table on the back.

3 Record your readings • Frequency and pitch

Sound source	Frequency (Hz)	High or low pitch?
Tuning fork 1		
Tuning fork 2		
Rubber band, loose		
Rubber band, tight		
Glass, less water		
Glass, more water		

3 Plot your results • Frequency and pitch

Draw a bar chart by hand. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) How close was the phone to the stamped value on the fork?

c) What changes the pitch of the rubber band and of the glass?

Exam-style questions

1. What is the audible range of frequencies for humans? (1 mark)

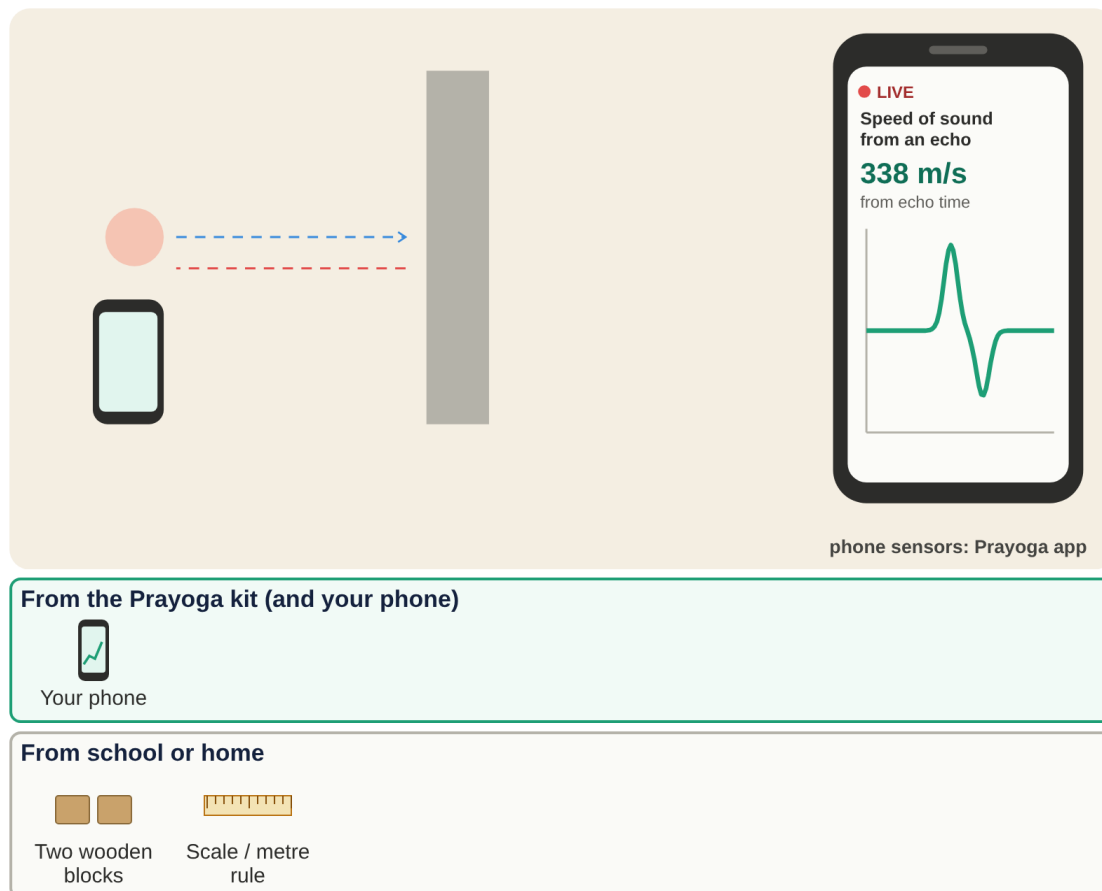
2. Define frequency and give its SI unit. (2 marks)

19. Speed of sound from an echo

Class 9 • Sound **Phone only (Prayoga app)**

Name _____ Class _____ Group _____ Date _____

You need: Phone with the Prayoga app, open ground with a tall wall, measuring tape, two wooden blocks.



Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

If the wall is 50 m away, the echo returns after about: ☐ 0.03 s ☐ 0.3 s ☐ 3 s

Why do you think so?

2 Measure by hand

1. Measure the distance to the wall with a measuring tape (or count steps after measuring your step length: 1 step = _____ m).

3 Set up Prayoga, then observe

Set up Prayoga

- No kit needed. Open the Prayoga app and choose this experiment. It opens the **Sound wave** view using the phone's microphone. Start just before the clap.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Stand at least 50 m from the wall. Open this experiment in the Prayoga app (it records the sound wave).
2. Clap the blocks once. Read the time between the clap and the echo. Repeat 3 times.

Write your readings in the table on the back.

3 Record your readings · Speed of sound from an echo

Trial	Distance d (m)	Time t (s)	Speed = $2d \div t$ (m/s)
1			
2			
3			
Average			

4 Explain

a) Was your prediction right? If not, what changed your mind?

b) Why do we use $2d$ and not d ?

c) Why must you stand at least 17 m away to hear a separate echo?

Exam-style questions

1. A person hears an echo 2 s after shouting near a cliff. If sound travels at 340 m/s, how far away is the cliff? (2 marks)

2. Give two uses of multiple reflection of sound. (2 marks)

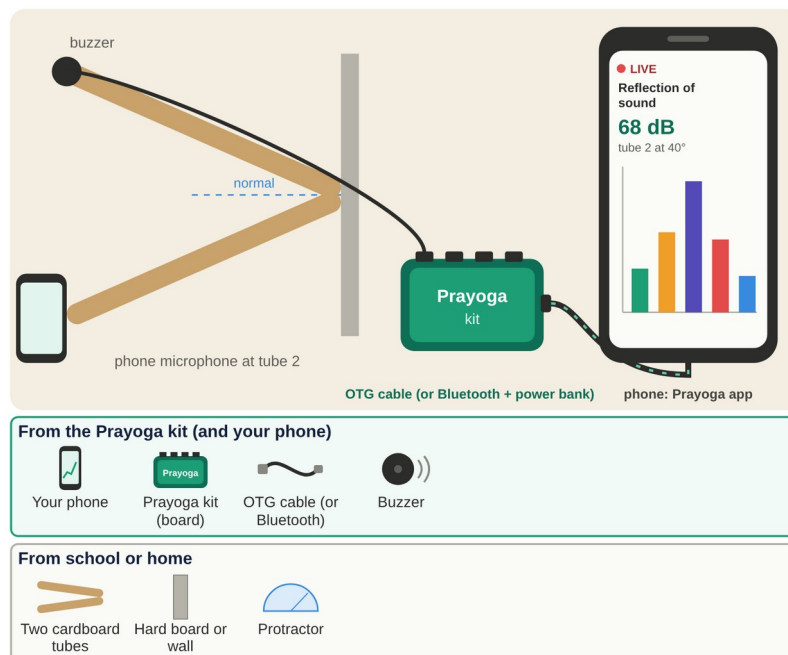
20. Reflection of sound

Class 9 • Sound **Basic kit + phone sensor**

Name _____ Class _____ Group _____ Date _____

You need: Prayoga kit (buzzer), phone with the Prayoga app, two cardboard tubes about 50 cm long, a smooth hard board (or wall), a protractor sheet on the table, books to hold the tubes.

Safety: The buzzer is quiet, but do not hold it against your ear.

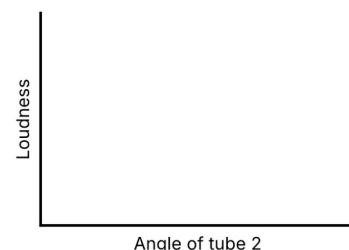


Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

Sound goes down tube 1 and reflects off the board. The sound in tube 2 will be loudest when: ☐ the two angles are equal ☐ tube 2 points straight at the board ☐ at any angle

Why do you think so?



Sketch the graph you expect

2 Measure by hand

1. Draw the normal (a line at 90° to the board) on the protractor sheet. Set tube 1 at 40° from the normal and check it with the protractor: _____ $^\circ$.

3 Set up Prayoga, then observe

Set up Prayoga

- Plug the buzzer into the kit and push it into the end of tube 1.
- Connect the kit: OTG cable to the phone (cable mode), or power bank in and Bluetooth on (wireless mode). Open the Prayoga app and choose this experiment. It opens the **Reflection of sound** view and draws the live graph. The app turns the buzzer on and reads the loudness from the phone's microphone.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Put the buzzer at the far end of tube 1, both tubes touching the protractor sheet, aimed at the same point on the board.
2. Hold the phone's microphone at the end of tube 2. Move tube 2 from 20° to 60° in 10° steps and record the loudness at each.
3. Repeat with tube 1 at 30° .

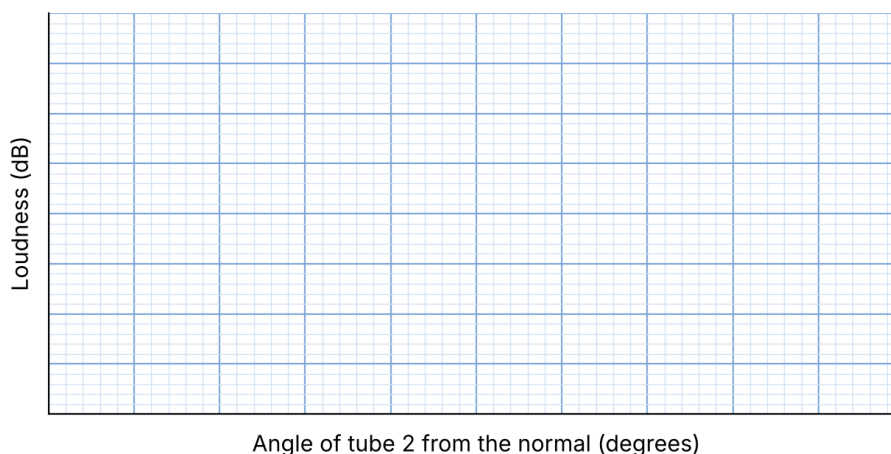
Write your readings in the table on the back.

3 Record your readings • Reflection of sound

Angle of tube 2 from the normal (°)	Loudness, tube 1 at 40° (dB)	Loudness, tube 1 at 30° (dB)
20		
30		
40		
50		
60		

3 Plot your results • Reflection of sound

Plot your points by hand and draw the best line or smooth curve. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) At which angle of reflection was the sound loudest? Compare it with the angle of incidence.

c) Why must both tubes and the normal lie flat on the same sheet?

Exam-style questions

1. State the laws of reflection of sound. (2 marks)

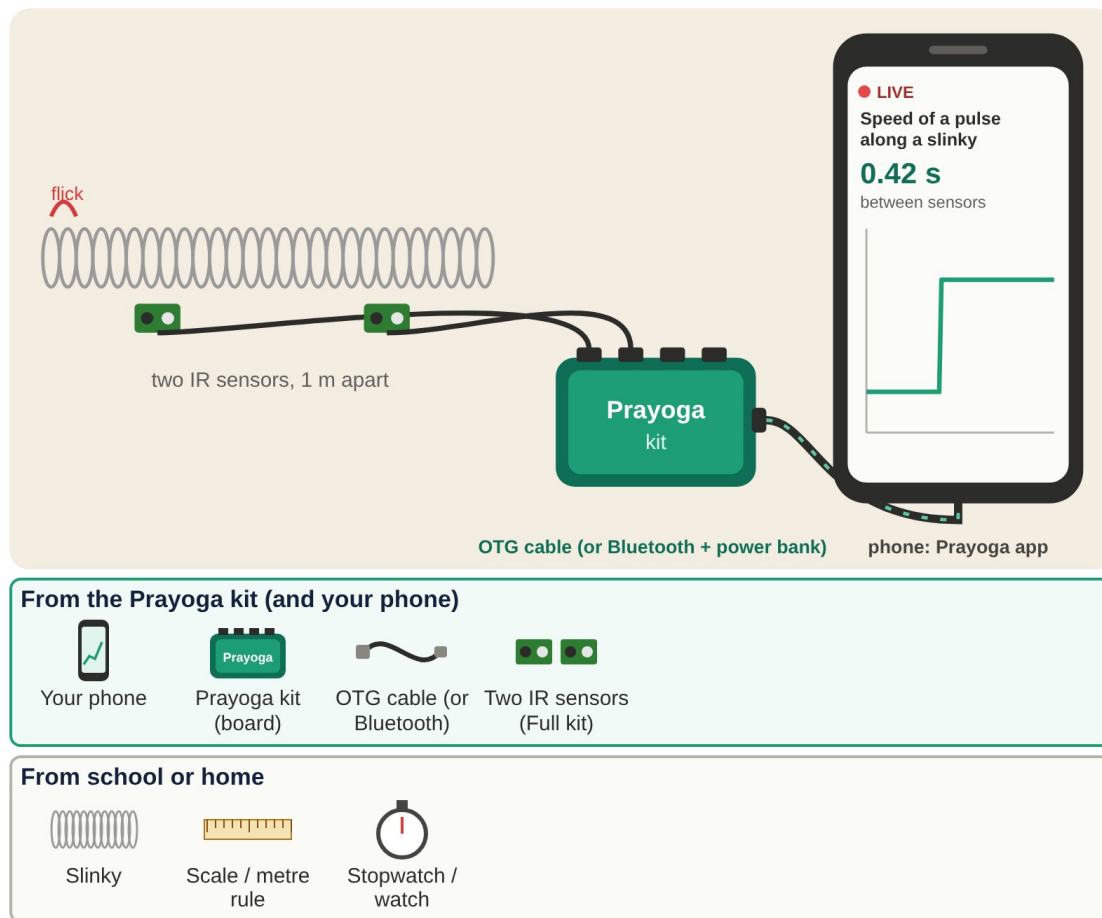
2. Give two uses of the reflection of sound. (2 marks)

21. Speed of a pulse along a slinky

Class 9 • Sound (waves) **Full kit**

Name _____ Class _____ Group _____ Date _____

You need: Prayoga kit with two IR sensors (Full kit), phone with the Prayoga app, a slinky, a smooth floor or long table, metre scale, stopwatch, tape.



Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

If the slinky is stretched more, the pulse will travel: ☐ faster ☐ slower ☐ at the same speed

Why do you think so?

2 Measure by hand

1. Measure the gap between the two IR sensors: _____ m. Also time a pulse along the whole slinky with a stopwatch (3 tries) and work out the speed.

3 Set up Prayoga, then observe

Set up Prayoga

- Plug the two IR sensors into the kit and place them beside the slinky.
- Connect the kit: OTG cable to the phone (cable mode), or power bank in and Bluetooth on (wireless mode). Open the Prayoga app and choose this experiment. It opens the **Pulse timer** view and draws the live graph. It shows the time between the two sensors.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Stretch the slinky to 2 m on the floor and tape both ends. Place the two IR sensors 1 m apart, about 1 cm beside the coils.
2. Flick one end sideways once. The app shows the time the pulse took between the sensors.
3. Do 3 tries, then stretch the slinky to 3 m and repeat.

Write your readings in the table on the back.

3 Record your readings · Speed of a pulse along a slinky

Stretch (m)	Sensor gap d (m)	Time t (s)	Speed = $d \div t$ (m/s)
2 (try 1)			
2 (try 2)			
2 (try 3)			
3 (try 1)			
3 (try 2)			
3 (try 3)			

4 Explain

a) Was your prediction right? If not, what changed your mind?

b) Compare the sensor time with your stopwatch time. Which is more reliable, and why?

c) Did stretching change the speed? Why?

Exam-style questions

1. What is a pulse? Is the pulse made by a sideways flick transverse or longitudinal? (2 marks)

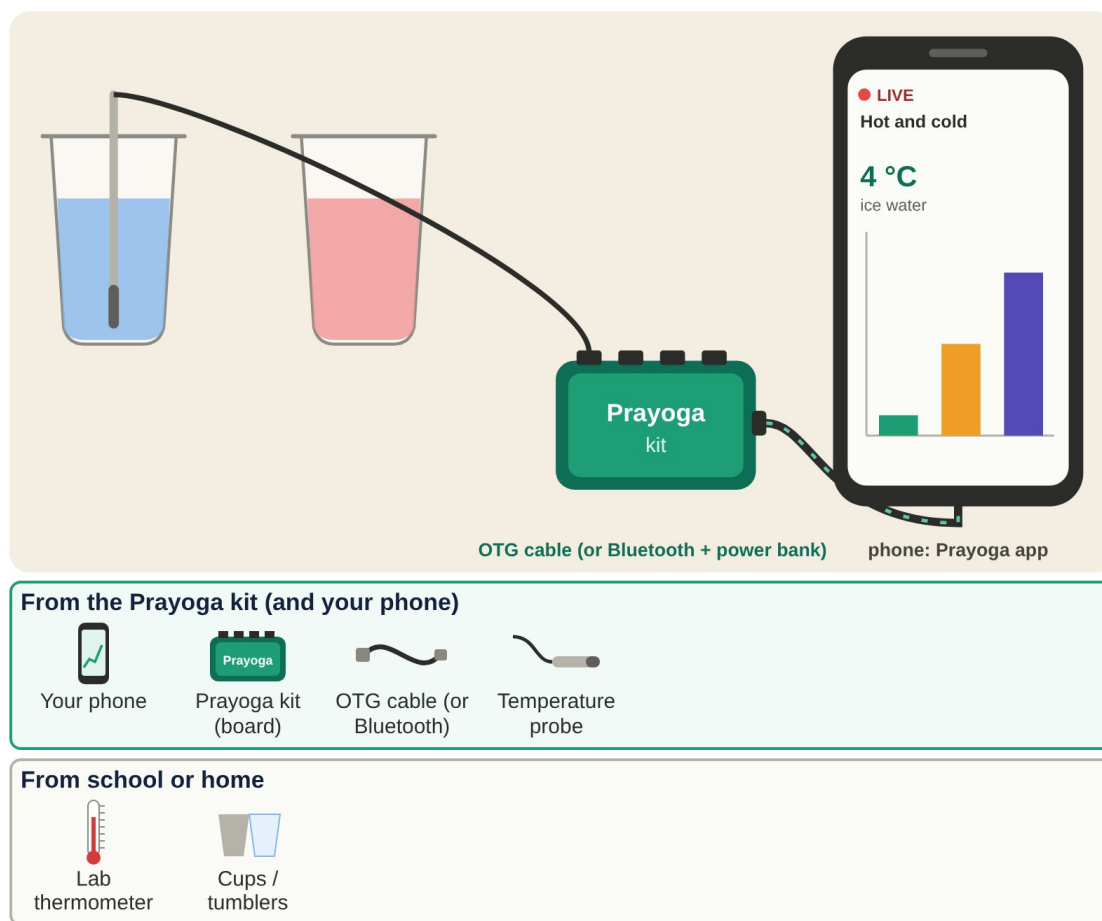
2. A pulse travels 3 m in 0.6 s. Find its speed. (1 mark)

22. Hot and cold

Class 7 • Heat **Basic kit**

Name _____ Class _____ Group _____ Date _____

You need: Prayoga kit (temperature probe), lab thermometer, three cups: ice water, tap water, warm water.



Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

Dip a finger in each cup first. Guess the temperatures: ice water _____ °C tap water _____ °C warm water _____ °C
Why do you think so?

2 Measure by hand

1. Read the lab thermometer in each cup at eye level, without touching the bulb. Least count: _____ °C.

3 Set up Prayoga, then observe

Set up Prayoga

- Plug the temperature probe into the kit.
- Connect the kit: OTG cable to the phone (cable mode), or power bank in and Bluetooth on (wireless mode). Open the Prayoga app and choose this experiment. It opens the **Temperature** view and draws the live graph. Check it shows room temperature before you start.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Measure each cup with the thermometer and with the probe.
2. Hold the probe in your closed fist for one minute and read it.

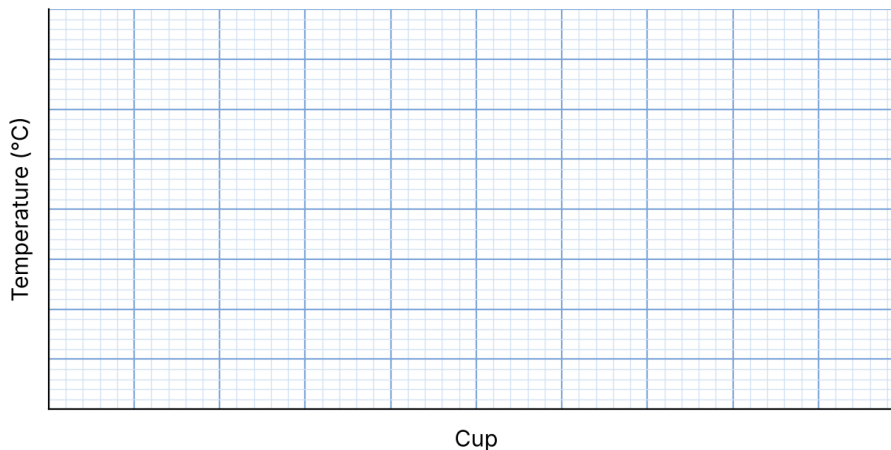
Write your readings in the table on the back.

3 Record your readings • Hot and cold

Water	Your guess (°C)	Thermometer (°C)	Sensor (°C)
Ice water			
Tap water			
Warm water			
Your closed fist		—	

3 Plot your results • Hot and cold

Draw a bar chart by hand. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) How good were your guesses? Why can touch be misleading?

c) Why should a clinical thermometer not be used for hot water?

Exam-style questions

1. Normal human body temperature is _____ °C. (1 mark)

2. Write two differences between a clinical and a laboratory thermometer. (2 marks)

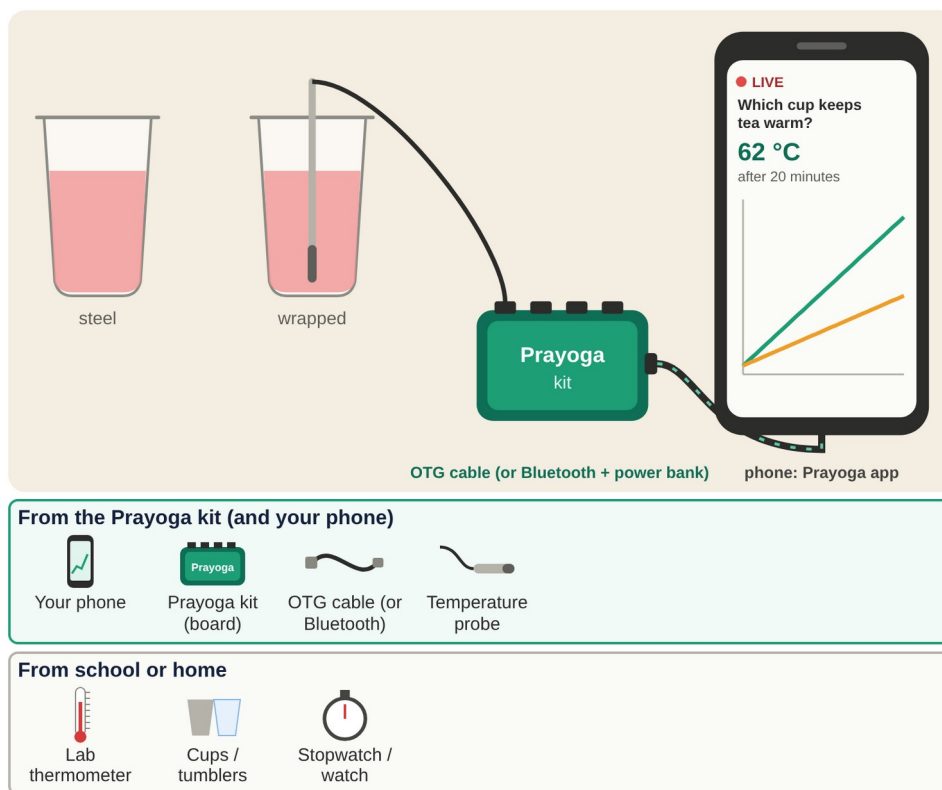
23. Which cup keeps tea warm?

Class 7 • Heat **Basic kit**

Name _____ Class _____ Group _____ Date _____

You need: Prayoga kit (temperature probe), lab thermometer, steel tumbler, plastic cup, a cup wrapped in cloth, hot water (poured by the teacher), watch.

Safety: Only the teacher pours hot water.

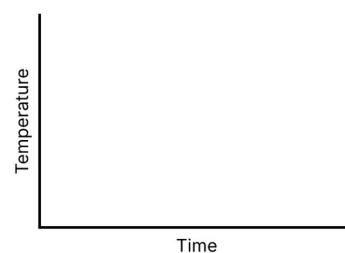


Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

Which cup will keep the water hottest after 20 minutes? ☐ steel ☐ plastic ☐ wrapped in cloth

Why do you think so?



Sketch the graph you expect

2 Measure by hand

1. Use the thermometer to read all three cups at 0, 10 and 20 minutes.

3 Set up Prayoga, then observe

Set up Prayoga

- Plug the temperature probe into the kit.
- Connect the kit: OTG cable to the phone (cable mode), or power bank in and Bluetooth on (wireless mode). Open the Prayoga app and choose this experiment. It opens the **Temperature** view and draws the live graph. Check it shows room temperature before you start.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Pour the same amount of hot water into each cup.
2. Leave the probe in the wrapped cup to record the whole cooling curve.

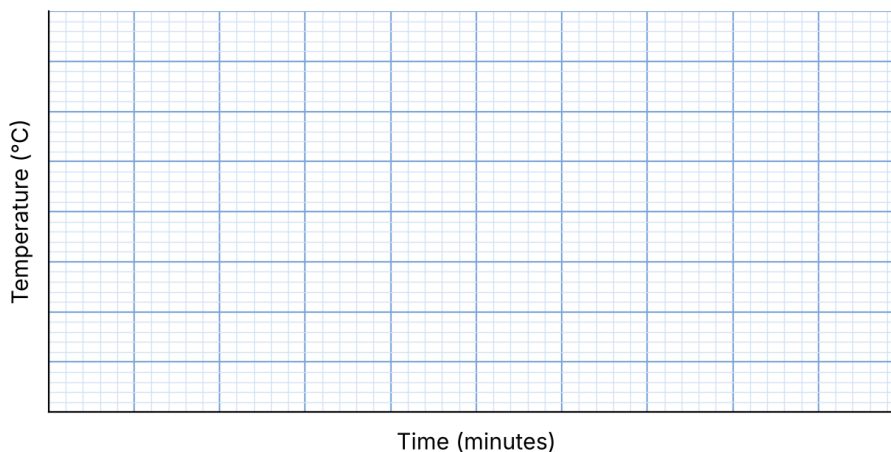
Write your readings in the table on the back.

3 Record your readings • Which cup keeps tea warm?

Cup	Start (°C)	After 10 min (°C)	After 20 min (°C)	Drop (°C)
Steel				
Plastic				
Wrapped in cloth				

3 Plot your results • Which cup keeps tea warm?

Plot your points by hand and draw the best line or smooth curve. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) Rank the cups. Explain using the words conductor and insulator.

c) Why do we wear woollen clothes in winter?

Exam-style questions

1. Name the three ways in which heat is transferred. (1 mark)

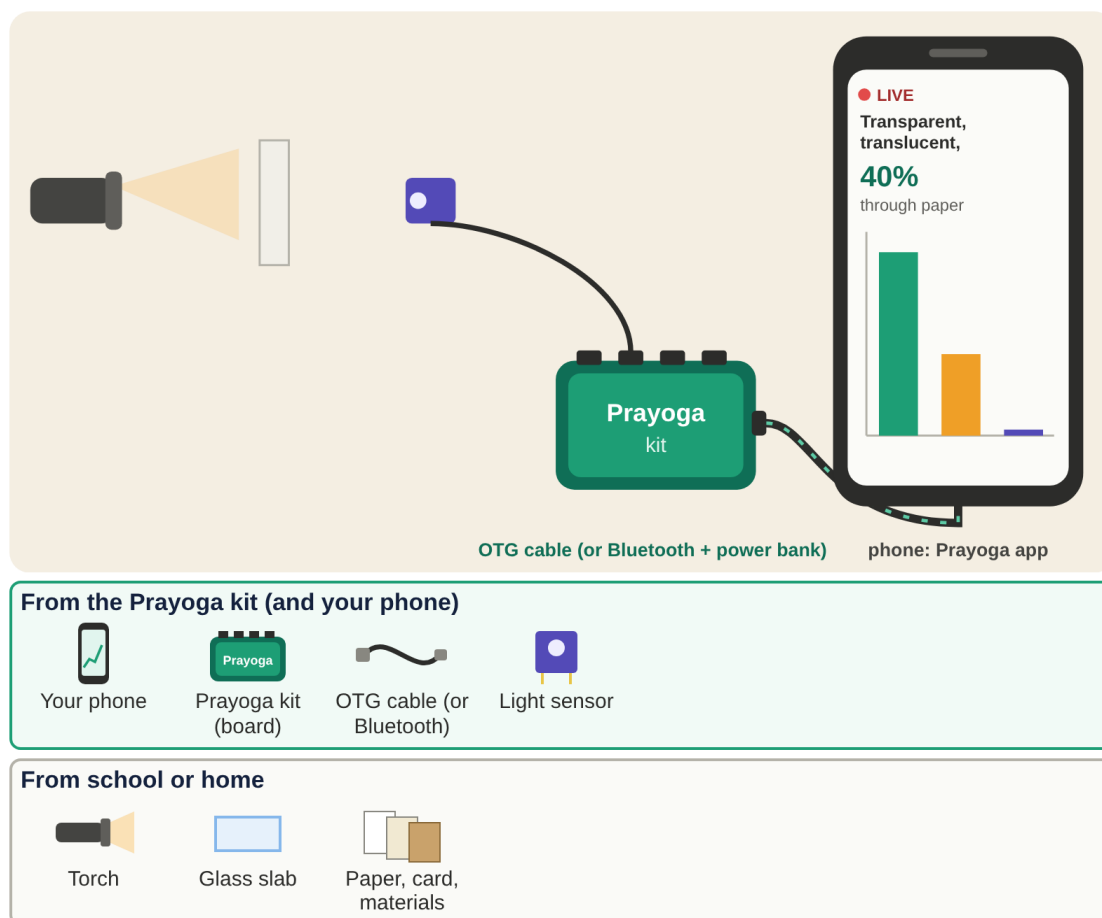
2. Why are cooking pans made of metal but have plastic or wooden handles? (2 marks)

24. Transparent, translucent, opaque

Class 6 • Light, Shadows and Reflections **Basic kit**

Name _____ Class _____ Group _____ Date _____

You need: Prayoga kit (light sensor), torch, glass, butter paper, notebook paper, cardboard, wooden ruler.



Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

Sort before testing: which will let light through? ☐ glass ☐ butter paper ☐ cardboard ☐ wood

Why do you think so?

2 Measure by hand

1. Look through each material at a window. Write “clear”, “blurred” or “can’t see”.

3 Set up Prayoga, then observe

Set up Prayoga

- Plug in the light sensor and point it at the light source.
- Connect the kit: OTG cable to the phone (cable mode), or power bank in and Bluetooth on (wireless mode). Open the Prayoga app and choose this experiment. It opens the **Light** view and draws the live graph.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Fix the torch 20 cm from the sensor. Record the reading with nothing between.
2. Put each material between them; record and work out the percentage.

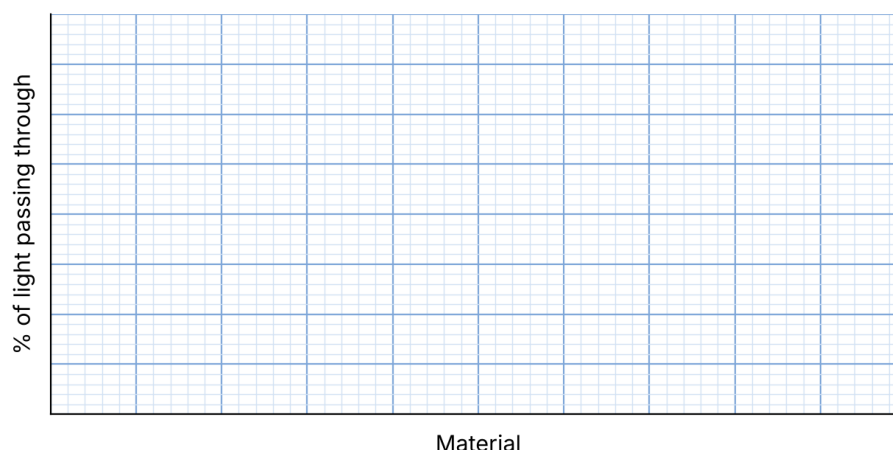
Write your readings in the table on the back.

3 Record your readings • Transparent, translucent, opaque

Material	What you see through it	Brightness (lux)	% of no-material reading	Transparent / translucent / opaque
Nothing	—		100	—
Glass				
Butter paper				
Notebook paper				
Cardboard				
Wood				

3 Plot your results • Transparent, translucent, opaque

Draw a bar chart by hand. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) Did the sensor agree with your eyes?

c) Why does an opaque object make a shadow?

Exam-style questions

1. Sort into transparent, translucent and opaque: frosted glass, wood, clean water, oiled paper. (2 marks)

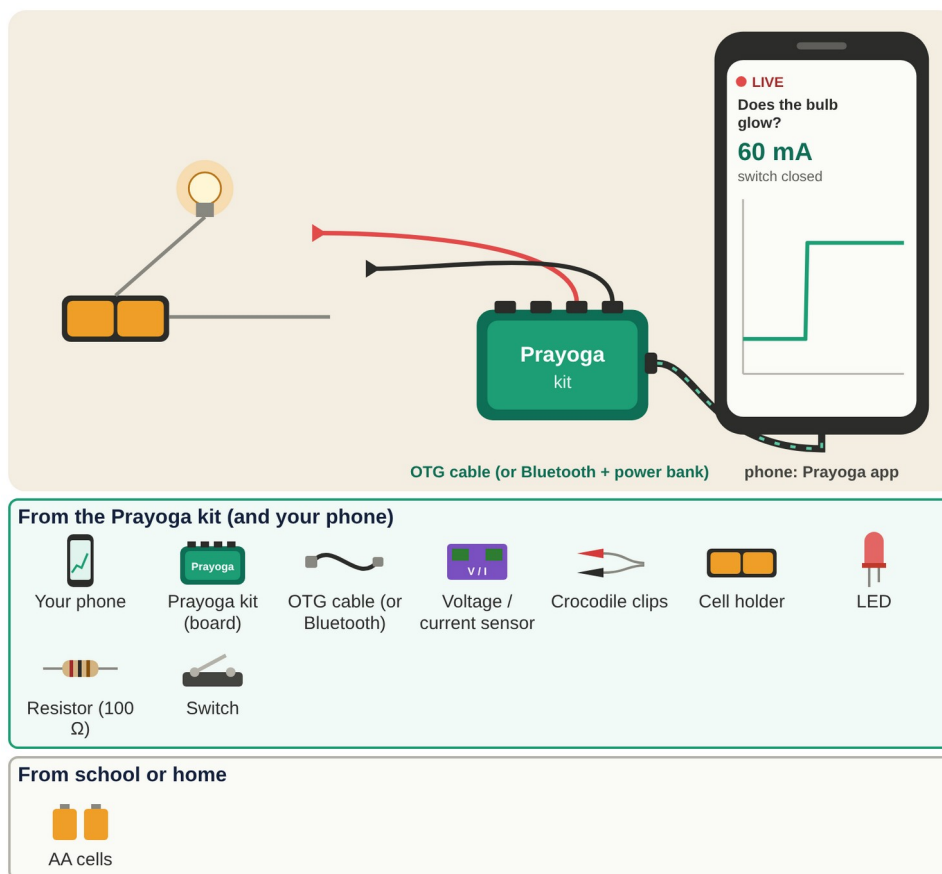
2. What three things do we need to see a shadow? (1 mark)

25. Does the bulb glow?

Class 6 • Electricity and Circuits **Basic kit**

Name _____ Class _____ Group _____ Date _____

You need: Prayoga kit, holder for 2 AA cells, LED with a $100\ \Omega$ resistor (or a torch bulb), a switch, wires.



Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

With the switch open, the current will be: ☐ zero ☐ small ☐ the same as when closed

Why do you think so?



Sketch the graph you expect

2 Measure by hand

1. Draw your circuit using the symbols for cell, bulb (or LED) and switch.

3 Set up Prayoga, then observe

Set up Prayoga

- Clip the circuit to the voltage/current sensor as in the steps below.
- Connect the kit: OTG cable to the phone (cable mode), or power bank in and Bluetooth on (wireless mode). Open the Prayoga app and choose this experiment. It opens the **Voltage and current** view and draws the live graph.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Cell + $\rightarrow$ VIN+; VIN- $\rightarrow$ switch $\rightarrow$ LED and resistor $\rightarrow$ cell - and kit GND.
2. Open and close the switch. Loosen one wire. Reverse the cell.

Write your readings in the table on the back.

3 Record your readings · Does the bulb glow?

Situation	Glow? (yes / no)	Current (mA)
Switch closed		
Switch open		
One wire loose		
Cell reversed		

4 Explain

a) Was your prediction right? If not, what changed your mind?

b) What is a closed circuit? What is an open circuit?

c) Why does an LED not glow when the cell is reversed?

Exam-style questions

1. What does a switch do in a circuit? (1 mark)

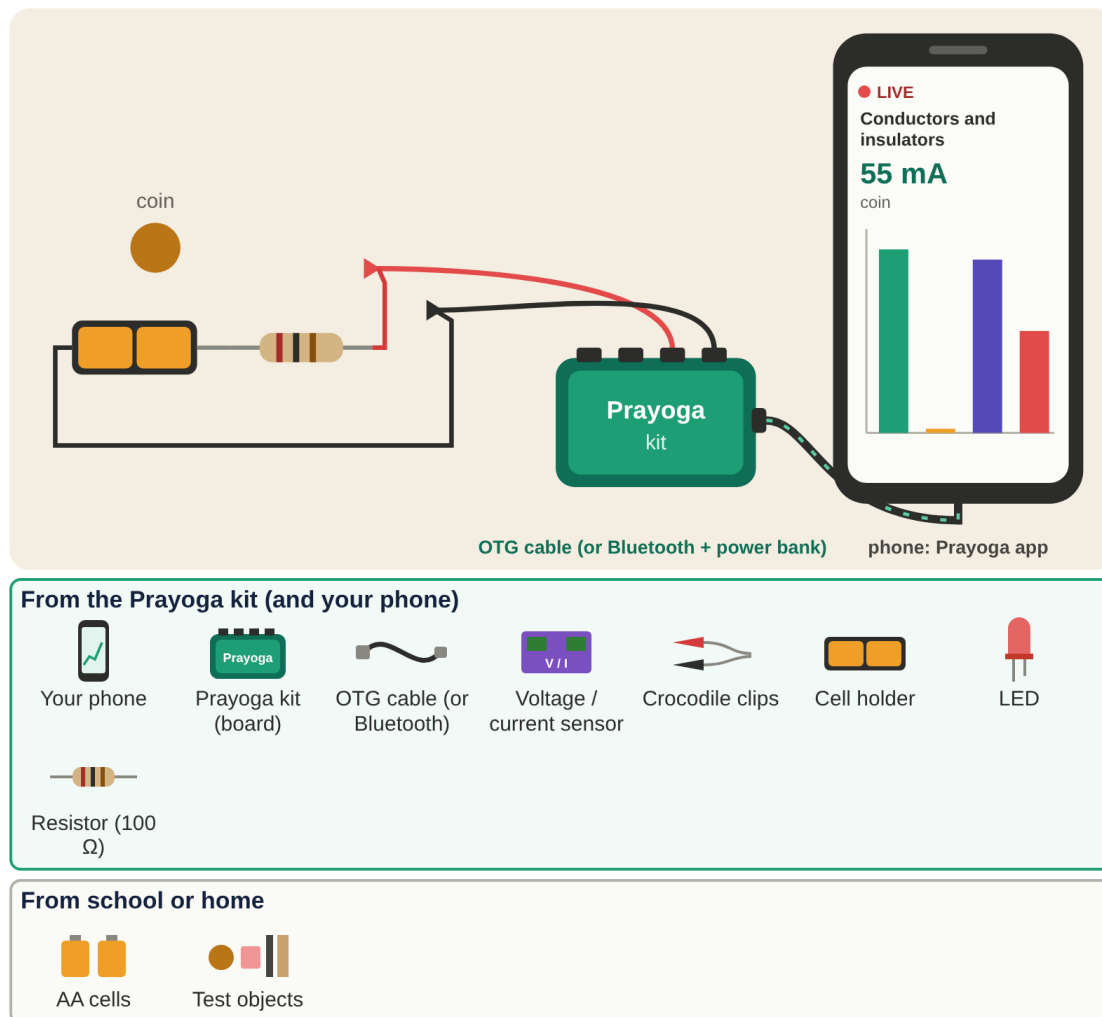
2. Draw a circuit diagram with a cell, a bulb and a switch. (2 marks)

26. Conductors and insulators

Class 6 • Electricity and Circuits **Basic kit**

Name _____ Class _____ Group _____ Date _____

You need: Circuit from the previous worksheet with a gap between two clips; iron key, coin, aluminium foil, pencil lead, eraser, plastic scale, wooden stick.



Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

Guess first: write C (conductor) or I (insulator) in the "Guess" column.

Why do you think so?

2 Measure by hand

1. If you have a multimeter, measure the resistance (Ω) of the coin and the eraser.

3 Set up Prayoga, then observe

Set up Prayoga

- Build the test circuit: battery + $\rightarrow$ VIN+; VIN- $\rightarrow$ LED with 100 Ω resistor $\rightarrow$ clip A; clip B $\rightarrow$ battery - and kit GND.
- Connect the kit: OTG cable to the phone (cable mode), or power bank in and Bluetooth on (wireless mode). Open the Prayoga app and choose this experiment. It opens the **Voltage and current** view and draws the live graph.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Place each object across the gap. Read the current.

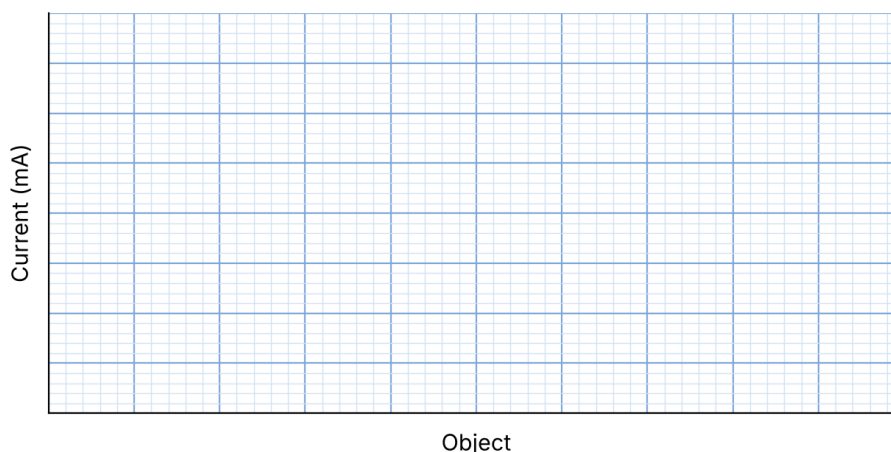
Write your readings in the table on the back.

3 Record your readings • Conductors and insulators

Object	Guess (C / I)	Current (mA)	Conductor or insulator?
Iron key			
Coin			
Aluminium foil			
Pencil lead			
Eraser			
Plastic scale			
Wooden stick			

3 Plot your results • Conductors and insulators

Draw a bar chart by hand. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) Which result surprised you?

c) Pencil lead is not a metal but it conducts. What is it made of?

Exam-style questions

1. Why are electric wires covered with plastic? (1 mark)

2. Name two conductors and two insulators. (2 marks)

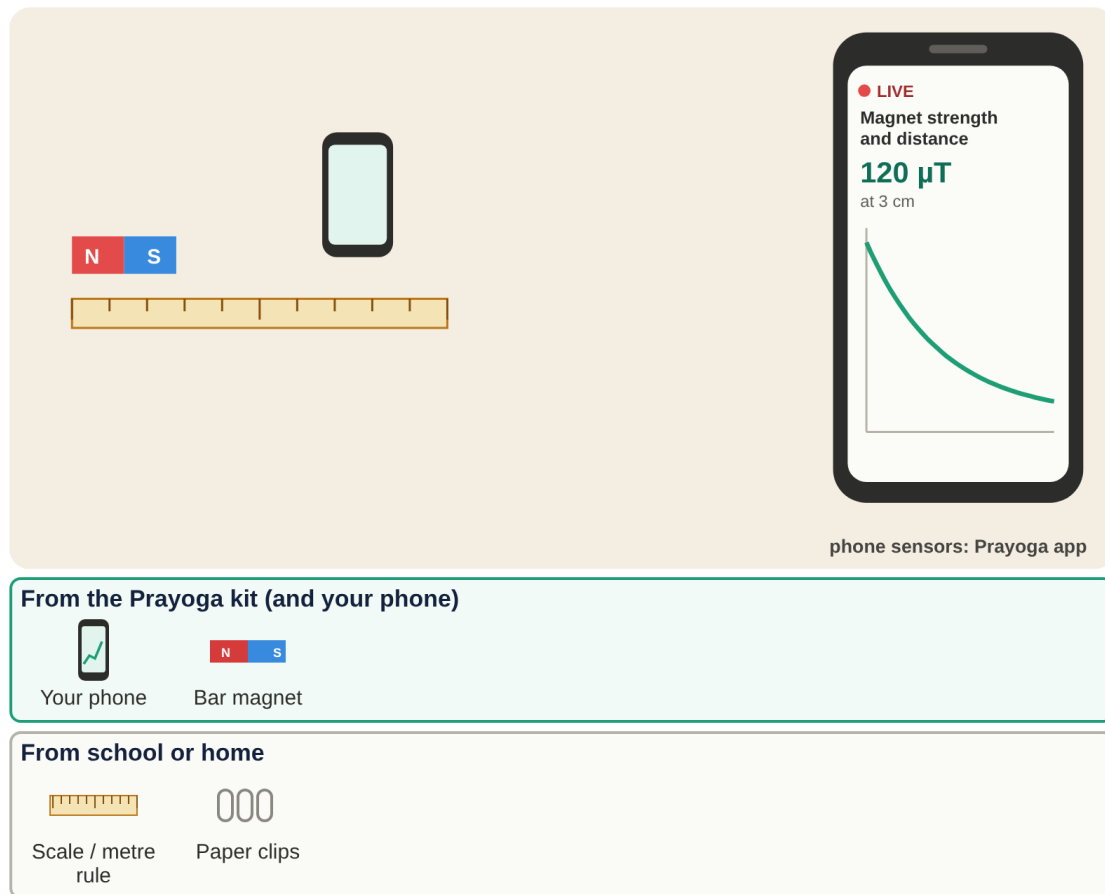
27. Magnet strength and distance

Class 6 • Fun with Magnets **Phone only (Prayoga app)**

Name _____ Class _____ Group _____ Date _____

You need: Phone with the Prayoga app, bar magnet, scale, paper clips.

Safety: Do not let the magnet touch the phone.



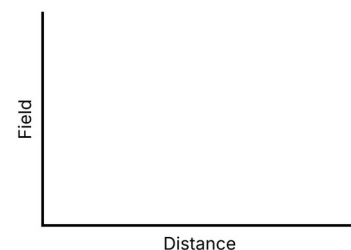
Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

Moving the magnet from 2 cm to 4 cm, its field will become: ☐ half

☐ much less than half ☐ the same

Why do you think so?



Sketch the graph you expect

2 Measure by hand

1. Count how many paper clips the magnet can hold in a hanging chain: _____

3 Set up Prayoga, then observe

Set up Prayoga

- No kit needed. Open the Prayoga app and choose this experiment. It opens the **Magnetic field** view using the phone's magnetometer. Lay the phone flat and keep it still.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Open this experiment in the Prayoga app (it uses the phone's magnetometer). Note the reading with no magnet near.
2. Place the magnet in line with the phone at 10 cm, then 8, 6, 4, 3 and 2 cm.

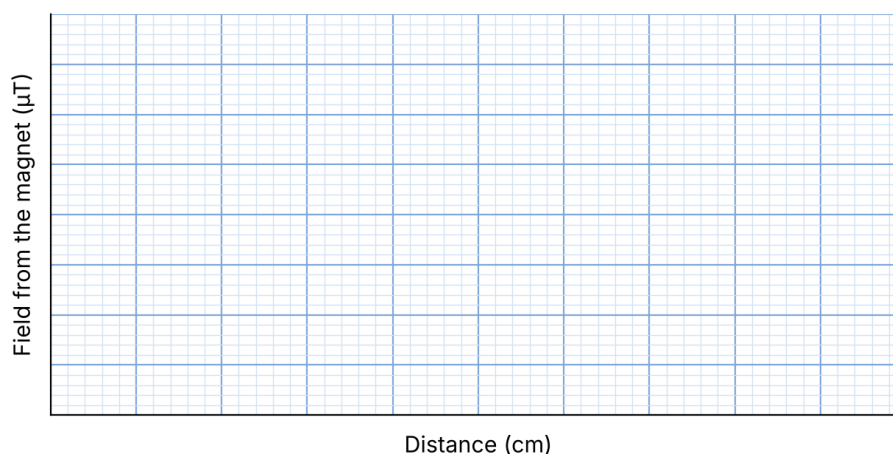
Write your readings in the table on the back.

3 Record your readings • Magnet strength and distance

Distance (cm)	Field (μT)	Field – no-magnet reading (μT)
10		
8		
6		
4		
3		
2		

3 Plot your results • Magnet strength and distance

Plot your points by hand and draw the best line or smooth curve. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) Does the field fall evenly or very quickly?

c) Which part of the magnet gives the biggest reading?

Exam-style questions

1. Where is the attraction of a bar magnet strongest? (1 mark)

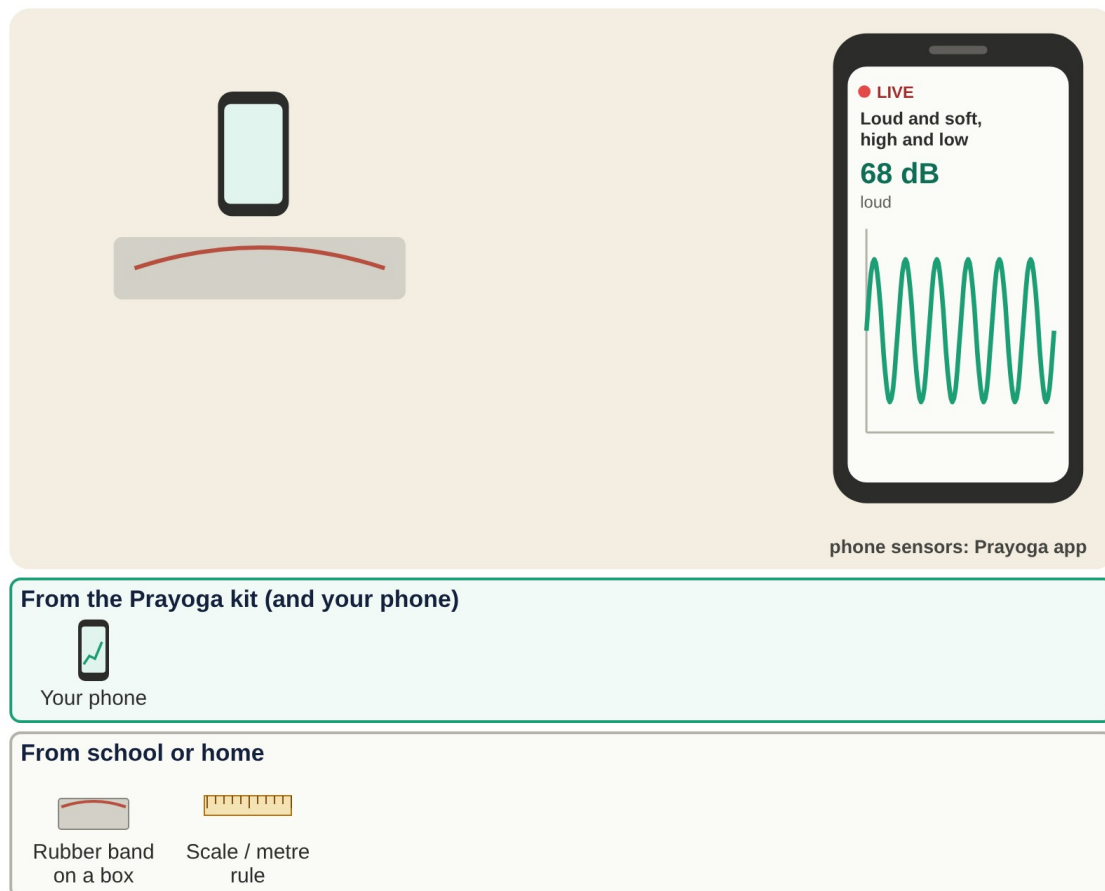
2. Name two magnetic and two non-magnetic materials. (2 marks)

28. Loud and soft, high and low

Class 8 • Sound **Phone only (Prayoga app)**

Name _____ Class _____ Group _____ Date _____

You need: Phone with the Prayoga app, a rubber band stretched over a box, a steel scale held on the edge of a desk.



Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

Plucking the band harder makes the sound: ☐ louder ☐ higher ☐ both

Why do you think so?

2 Measure by hand

1. Measure how much of the steel scale sticks out over the desk: 10 cm and 20 cm.

3 Set up Prayoga, then observe

Set up Prayoga

- No kit needed. Open the Prayoga app and choose this experiment. It opens the **Loudness and sound wave** view using the phone's microphone. Keep the phone the same distance from the sound.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Open this experiment in the Prayoga app: it shows loudness (dB) and the sound wave.
2. Pluck the band softly and hard. Twang the scale at 10 cm and 20 cm.

Write your readings in the table on the back.

3 Record your readings · Loud and soft, high and low

Sound	Loudness (dB)	Wave tall or short?	Waves close or far apart?
Band plucked softly			
Band plucked hard			
Scale, 10 cm out			
Scale, 20 cm out			

4 Explain

a) Was your prediction right? If not, what changed your mind?

b) What changes when the sound is louder: the height or the spacing of the wave?

c) Why does the shorter scale give a higher pitch?

Exam-style questions

1. Loudness depends on the _____ and pitch depends on the _____ of the vibration. (2 marks)

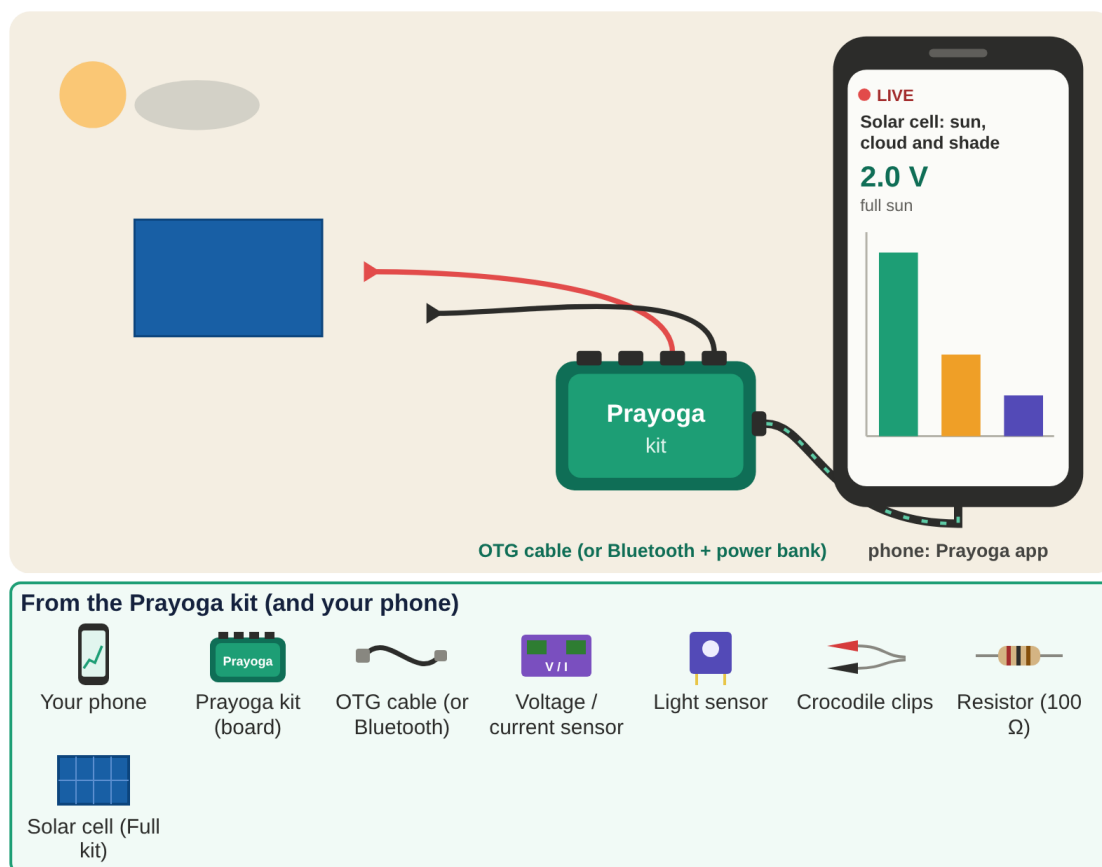
2. What is noise pollution? Give one way to reduce it. (2 marks)

29. Solar cell: sun, cloud and shade

Class 8 • Sources of Energy **Full kit**

Name _____ Class _____ Group _____ Date _____

You need: Prayoga kit (voltage/current and light sensors), small solar cell, 100 Ω resistor.



Above: how the parts connect, and every instrument you need. The animated version is on the Prayoga setup page.

1 Predict (before you touch the kit)

On a cloudy day the solar cell's output will be: ☐ about the same ☐ lower ☐ zero

Why do you think so?

2 Measure by hand

1. Note the time and describe the sky each time: clear, some cloud or overcast.

3 Set up Prayoga, then observe

Set up Prayoga

- Connect the solar cell as in the Class 10 solar-cell worksheet and place the light sensor next to it.
- Connect the kit: OTG cable to the phone (cable mode), or power bank in and Bluetooth on (wireless mode). Open the Prayoga app and choose this experiment. It opens the **Solar cell and light** view and draws the live graph.
- Tap Start to record and Stop to finish. Tap Save to keep the readings; they can be shared as a spreadsheet.

1. Connect the solar cell as in the Class 10 solar-cell worksheet.
2. At the same spot, record light, voltage and current at different times and places.

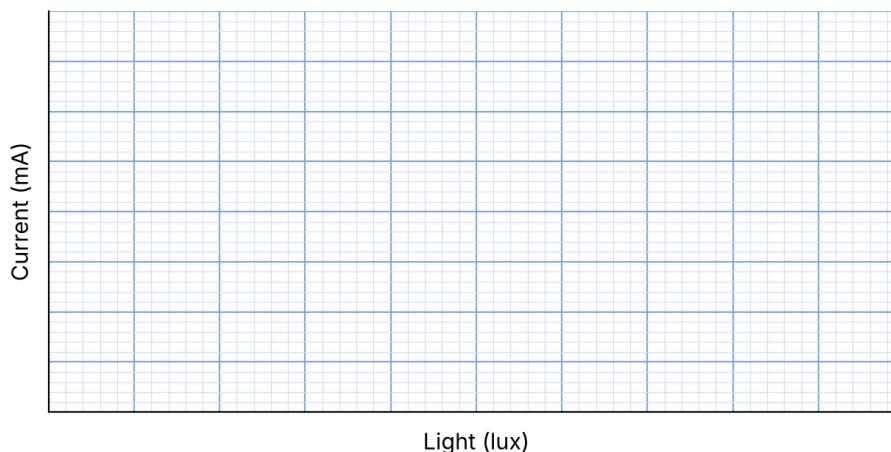
Write your readings in the table on the back.

3 Record your readings • Solar cell: sun, cloud and shade

Time and sky	Light (lux)	Voltage (V)	Current (mA)
Morning sun			
Noon sun			
Cloudy			
Shade			
Indoors			

3 Plot your results • Solar cell: sun, cloud and shade

Plot your points by hand and draw the best line or smooth curve. Choose a scale that uses most of the grid. Then compare with the app's graph.



4 Explain

a) Was your prediction right? If not, what changed your mind?

b) Does more light always give more output?

c) Where in your school would you put a solar panel? Why?

Exam-style questions

1. Solar cells change _____ energy into _____ energy. (1 mark)

2. Give two uses of solar cells. (2 marks)

Teacher answer key

1. Ohm's law

- About 15, 30, 45, 60 mA at 1.5, 3, 4.5, 6 V (a little lower with used cells); $R \approx 100 \Omega$ in every row, within 5%.
- Straight line through zero: $V \propto I$; slope = R . Watch for mA not changed to A.
- Ohm's law: at constant temperature, current through a conductor is proportional to the voltage across it ($V = IR$). Ammeter in series, voltmeter in parallel across the resistor.

2. Resistance and length of a wire

- R rises in a straight line with length ($R \propto l$); $R \div \text{length}$ roughly constant (about $0.1\text{--}0.2 \Omega/\text{cm}$ for thin nichrome).
- Factors: length, area of cross-section, material (resistivity), temperature; $R = \rho l/A$.
- Each half: 3Ω .

3. Resistors in series and parallel

- With 6 V: one $100 \Omega \approx 60 \text{ mA}$; series $200 \Omega \approx 30 \text{ mA}$; parallel $50 \Omega \approx 120 \text{ mA}$.
- Series 10Ω ; parallel 2.4Ω .
- Parallel: each appliance gets the full voltage; one failing does not stop the others; each can be switched separately.

4. Heating effect of current

- Expect a rise of a few $^{\circ}\text{C}$. Doubling the current gives roughly four times the rise ($H = I^2Rt$), a little less in practice because heat escapes.
- Joule's law: heat produced is proportional to the square of the current, the resistance and the time ($H = I^2Rt$).
- $H = 0.3^2 \times 20 \times 300 = 540 \text{ J}$.
- Nichrome: high resistivity, high melting point, does not oxidise easily.

5. Magnetic field around a wire

- The change falls as distance rises, roughly halving when distance doubles ($B \propto 1/r$). With about 0.25 A in a 10-turn bundle, expect tens of μT at 1 cm .
- Reversing the current reverses the field, so the reading changes the other way.
- Right-hand thumb rule: hold the wire in the right hand with the thumb along the current; the fingers curl in the direction of the field. Field lines are concentric circles.

6. Field of a solenoid

- Field rises roughly in proportion to the number of turns.
- Solenoid: a coil of many circular turns of insulated wire; the field inside is uniform, like a bar magnet.
- More turns, more current, a soft iron core.

7. Magnet through a coil (induction)

- A spike one way going in and the opposite way coming out; none when still; bigger when faster; reverses with the other pole.
- Electromagnetic induction: a current is produced in a coil when the magnetic field through it changes.
- Fleming's right-hand rule: thumb = motion, forefinger = field, middle finger = induced current, all at right angles.

8. Light and distance

- A curve: brightness falls quickly, then slowly; from 10 to 20 cm it drops to about one quarter.
- Brightness $\times d^2$ is roughly constant, especially at larger distances. A phone torch has a lens, so close readings may not fit: a good discussion point.
- About 4 times brighter.

9. Light through glass and water

- One slab lets through roughly $85\text{--}92\%$; two slabs less; the water box less again; paper much less.
- Light is lost by reflection at each surface and by absorption inside the material.
- Refraction: bending of light as it passes from one medium into another. Refractive index 1.5 : light travels 1.5 times faster in vacuum (air) than in glass.

10. Spectrum of different lamps

- Order: violet, indigo, blue, green, yellow, orange, red. Filament bulb and daylight give a smooth band; tube lights show bright separate lines; white LEDs show a strong blue band plus a broad yellow band; phone screens show red, green and blue patches.
- Violet bends most, red least: each colour travels at a different speed in glass.
- Dispersion: splitting of white light into its component colours.

11. Why the sky is blue

- Straight-through light falls; side light rises at first. The side looks bluish and the end looks orange.
- Tiny particles scatter blue light more than red (scattering of light). At sunset light travels through more air, so most blue is scattered away and red reaches us.
- Red is scattered least, so it can be seen from far away, even in fog.

12. Solar cell output

- Largest facing the light; falls as the angle grows (roughly with cos of the angle), near zero at 90°. Half covering can cut output by more than half because the cells inside are in series.
- In Karnataka, face panels south, tilted roughly 12–15°.
- Advantages: no moving parts, little maintenance, no pollution. Limitations: costly, need sunlight, low efficiency.
- Solar panel: many solar cells connected together.

13. Inside a solar cooker

- On a sunny day the inside reaches roughly 60–100 °C, far above the air.
- Black surfaces absorb more heat; the glass lid traps heat (greenhouse effect); the reflector sends more sunlight in.
- Limitations: needs a sunny day, cooks slowly, cannot be used at night, must be turned to face the sun.

14. Trolley on a ramp: speed and acceleration

- Speed rises steadily: uniform acceleration. Steeper ramp, larger acceleration.
- Differences come from reaction time with the stopwatch, friction and the phone not being exactly along the ramp.
- $a = 2 \div 4 = 0.5 \text{ m/s}^2$. v - t graph: straight line sloping up from zero.

15. Force, mass and acceleration

- Acceleration falls as mass rises; mass $\times$ acceleration stays roughly constant: it is the force of the band.
- Same stretch means the same force, so only the mass changes (a fair test).
- Second law: rate of change of momentum is proportional to the force applied ($F = ma$). $a = 5 \text{ m/s}^2$.

16. Measuring g with a pendulum

- $T \approx 1.42, 1.74$ and 2.0 s ; $g \approx 9.8 \text{ m/s}^2$. $T^2 \propto L$ gives a straight line.
- Timing 10 swings spreads the stopwatch reaction error over 10 swings.
- $g = 9.8 \text{ m/s}^2$. The Moon has much less mass (and smaller radius), so g there is about one-sixth.

17. Energy in a swinging pendulum

- Predicted $v \approx 0.99, 1.40, 1.98 \text{ m/s}$; measured slightly less because of air resistance and friction.
- KE largest at the bottom; PE largest at the ends of the swing.
- Energy can be neither created nor destroyed, only changed from one form to another. $KE = mgh = 0.2 \times 10 \times 5 = 10 \text{ J}$.

18. Frequency and pitch

- The phone should be within a few Hz of the stamped value.
- Tighter band, higher pitch; the glass with more water gives a lower pitch when tapped.
- Audible range 20 Hz to 20,000 Hz. Frequency: number of vibrations per second; unit hertz (Hz).

19. Speed of sound from an echo

- About 0.29 s at 50 m; speed about 340 m/s.
- Sound goes to the wall and back. The ear keeps a sound for about 0.1 s, so the echo must take longer: $340 \times 0.1 \div 2 = 17 \text{ m}$.
- Distance = $340 \times 2 \div 2 = 340 \text{ m}$.

- Megaphone, stethoscope, curved ceilings in halls, sound boards.

20. Reflection of sound

- Loudest when the angle of reflection is about equal to the angle of incidence (within about $5-10^\circ$).
- Laws: the angle of incidence equals the angle of reflection; the incident sound, the reflected sound and the normal lie in the same plane.
- Uses: megaphone, stethoscope, sound boards in halls, echo-ranging (sonar).

21. Speed of a pulse along a slinky

- Typical speeds are a few m/s and depend on the slinky; more stretch (more tension) gives a faster pulse.
- The sensors remove reaction-time error, so they are more reliable than a stopwatch.
- A pulse is a single short disturbance. A sideways flick makes a transverse pulse (a push along the slinky makes a longitudinal one). Speed = 5 m/s.

22. Hot and cold

- Ice water about $0-5^\circ\text{C}$, tap water near room temperature, warm water $40-50^\circ\text{C}$, closed fist about $33-35^\circ\text{C}$ (skin is cooler than inside the body).
- Touch compares with your skin: after warm water, tap water feels cold.
- 37°C . Clinical: $35-42^\circ\text{C}$, has a kink; laboratory: about -10 to 110°C , no kink.

23. Which cup keeps tea warm?

- The wrapped cup cools slowest; steel usually fastest.
- Cloth and wool trap air, a poor conductor (insulator).
- Conduction, convection, radiation. Metal conducts heat to the food; the handle insulates the hand.

24. Transparent, translucent, opaque

- Transparent above about 80%, translucent roughly 10–60%, opaque close to 0%.
- Frosted glass and oiled paper: translucent; wood: opaque; clean water: transparent.
- A light source, an opaque object and a screen.

25. Does the bulb glow?

- Closed: about 10–15 mA with the LED; open or loose: 0; reversed: 0 for an LED.
- Current flows only in a complete (closed) loop. An LED lets current through one way only.
- A switch opens or closes the circuit.

26. Conductors and insulators

- Metals give about 10–15 mA; pencil lead a little less; eraser, plastic and wood about 0.
- Pencil lead is graphite, a form of carbon that conducts.
- Plastic is an insulator; it stops shocks.

27. Magnet strength and distance

- The field falls very quickly with distance, far faster than halving.
- Strongest at the poles (ends).
- Magnetic: iron, nickel, cobalt. Non-magnetic: wood, plastic, copper.

28. Loud and soft, high and low

- Louder: taller wave (larger amplitude). Higher pitch: waves closer together (higher frequency). A shorter scale vibrates faster.
- Amplitude; frequency.
- Noise pollution: unwanted loud sound. Reduce it with trees, silencers, lower volumes.

29. Solar cell: sun, cloud and shade

- Current rises with light; voltage rises at first and then levels off in bright light.
- Light (solar) energy into electrical energy.
- Calculators, street lights, water pumps, satellites.